EFORWOOD

TOSIA - A TOOL FOR SUSTAINABILITY IMPACT ASSESSMENT OF THE FOREST-WOOD CHAIN

This project is supported by the European Commission under the 6th Framework Programme for Research and Technological Development.

PHOTO: TAMMY HANRATTY/CORBIS

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Sustainable development is a core objective of the European Union: we need to ensure that our present socio-economic development does not compromise our future. Major support to the EU Strategy for Sustainable Development – decided 2001 at the Goteborg European Council, and renewed in 2006 – has been contributed by the research on global change and ecosystems done under FP6 – the 6th EU Framework Programme for Research and Technological Development. Clearly, sustainable development policies need to be scientifically underpinned by adequate scientific supporting tools and methodologies. Research done by the FP6 project EFORWOOD and results achieved have to be seen in the context of sustainable development, using the forest-based sector as study object. The three elements of sustainable development – economic, social and environmental – have been considered in equal measure throughout the project. EFORWOOD achieved its main target and developed the tool ToSIA (Tool for Sustainability Impact Assessment), a decision support tool for policy makers, industry and other stakeholders to identify sustainability impacts of existing and future forestry-wood chains.

PREFACE

MANUELA SOARES
Director
Research Directorate-General
European Commission

FP7 research continues to contribute to sustainable development, notably by developing scientifically sound tools to support decision-making needed for the successful implementation of genuinely sustainable policies. This remains a key concern of the European strategy for smart, sustainable and inclusive growth (Europe 2020 Strategy) proposed by the Commission to emerge from the economic and financial crisis and to achieve a sustainable future.

In this framework I would like to highlight and appreciate in particular the efforts by the EFORWOOD consortium to ensure the future uptake and use of the ToSIA tool, data bases and other project deliverables. The creation of an EFORWOOD "Management and User Group" bound together by a memorandum of understanding will surely enhance the impact of the research done and thus contribute to sustainable use of forests and forest-based products –a significant stepping stone in attaining sustainability.

"Within EU Industrial Policy and its Sustainable Development Strategy, which aim at creating better framework conditions for manufacturing industries, forest-based industries serve as an example of a sector very much in step with the evolution of EU policies. These industries are steadily modernising, putting knowledge and innovation to good effect, so as to consolidate their sustainability while meeting competitiveness challenges."

COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on innovative and sustainable forest-based industries in the EU.

STAKEHOLDER VIEWS AND COMMENTS

Hans Winsa, R&D Sveaskog

"Today and in the future, sustainable production of raw material as a base for consumer products with preferred environmental performance is as important as it was yesterday. This puts the production of wood-biomass into a unique position compared to other materials. The ToSIA project is addressing sustainability impact by adapting a decision support tool including economic, social and environmental dimensions to specific regional requirements. Sveaskog is interested in the development and testing of the tool. We hope that it will be possible to develop it into something that will be useful for sustainable forest management."

Hamish Trench, Head of Heritage and Land Management at the Cairngorms National Park Authority, Scotland

"The Cairngorms National Park Authority has engaged in the Northern ToSIA project to help inform policy choices and assessments of sustainability in the National Park. In particular, we see potential for ToSIA to help inform discussion about how and where forest expansion should take place in order to contribute to climate change targets, to help inform work to increase the use of wood as a fuel source and above all to help give an indication of the sustainability of forest management at a Park scale. We also hope we are able to help the project connect with the private forestry sector in order to get the best possible set of information and data to be of practical use."

Pasi Pitkänen, Regional planner Regional Council of North Karelia, Finland

"The ToSIA tool makes the analysis of different decisions possible and gives a good starting point to the discussions to find comprehensive solution to important issues. I would see that the tool can be adapted and developed for the many sectors in North Karelia in the future. The most important contribution of ToSIA to the Regional Council has probably been the different points of view of the forest energy that have been received from the discussions of decision-makers and experts of the region about matters which can be taken into consideration in the regional programme work."

"ToSIA is a decision-support tool that helps to provide objective answers to what-if questions, and to highlight the consequences of various conceivable futures. For instance, what effect would there be on greenhouse-gas emissions if the construction of timber buildings were to increase by 25%?"

EFORWOOD IN SHORT

EXECUTIVE SUMMARY

EFORWOOD, an EU-financed research programme, has developed ToSIA, a computerized decision-support tool that helps decision-makers in politics, government departments, industry, and other players to make sound and reliable decisions on forestry and forest products manufacturing and consumption leading to sustainable development.

ToSIA provides objective information that shows how changes in forestry and the forest products industry influence factors such as employment, the economy, biodiversity, and greenhouse-gas emissions.

"From past experience, I know how important it is, right from the start, to spell out exactly what ToSIA does not do," says Kaj Rosen, who has coordinated the research programme. "It is not an instrument for predicting the future, and nor is it a means of determining whether something is good or bad."
The term Value chain is central to ToSIA, and covers all the steps from forest to finished product, through to recovery, and end of life. Another central term is Sustainability, which includes three key elements: the economy, the environment, and social aspects. ToSIA uses indicators to describe these elements and how they change over time.

Change linked to a reference future

When ToSIA is employed to make an analysis, it uses a typical, hypothetical starting point for a value chain — known as a reference future. This describes an imaginary future that is built up of known existing factors.

When, at some time in the future, the politicians and other players make new decisions, the circumstances change in relation to the reference future. ToSIA then provides an assessment of how the indicators for sustainable development are affected. For example, what would be the impact of more intensive forestry on employment and the economy in Europe? What contribution could the forestry sector make to reduce our dependency on oil? What would happen if the harvesting of energy wood were to be increased at the cost of pulpwood? What would happen if the demand for newsprint were to decline or if we were to replace concrete buildings with timber buildings?

Intensive data collection

ToSIA can be seen as a calculator that, given certain conditions, can determine the wood and fibre flow in a value chain. Each process in the chain is described by means of a sustainability indicator. The data-collection work is intensive. Tens of thousands of details are required for a complete value chain.

The scale of the ToSIA analysis is optional. Geographically, an analysis could cover a single, individual property or region or be aggregated up to EU level. An analysis can be made of an entire value chain or just one part of it —forest management or work in a factory, for instance.

It is also possible to limit the analysis to just one or two sustainability indicators, thereby simplifying data collection, but this means that the assessment sustainability impact will be incomplete.

The program itself is free, but it will usually require the help of a consultant from the project consortium to run an analysis.

PHOTO: MATTON IMAGES

Comparing indicators - apples and oranges

Interpretation of the results from ToSIA is not straightforward. How, for instance, can you weigh an increase in employment against a reduction in biodiversity? To find solutions to these kinds of questions we have worked on a variety of techniques in the research programme aimed at helping the user to interpret the results. One such technique is multi-criteria analysis (MCA). This technique enables the user not only to put the various indicators into order of precedence but also to combine the indicators into a balanced outcome — a sustainability index — that makes it easier to put the various options into an order of precedence for sustainability. MCA makes it possible to compare variables that, in theory, cannot be compared — such as apples and oranges.

The analysis work can be carried out independently or in a group. In the latter case, the group results should be seen as the average outcome based on the values and assumptions of the participants. The method used can be seen as a model for negotiation, in which a group of decision-makers and other stakeholders in an interactive process vote on the importance of the different indicators, such as employment, and greenhouse-gas emissions

PHOTO:BIGSTOCK

Case studies

The testing of ToSIA involved four case studies.

1. The Scandinavian case, in which we analysed the effect on sustainable development if new technologies were introduced in sawmills (e.g. lumber-scanning).

2. The Baden Württemberg regional case, which analysed effects on the forestry sector if the newly adopted EU policy on renewable energy (the 20-20-20 policy) were to be fully implemented in the region.

3. The Iberian consumption-driven case focussed on consumer behaviour

4. The EU case, in which we analysed what would happen to the sustainability of the European forestry sector if the nature conservation directive (Natura 2000) were implemented on a more ambitious scale in the EU.

Availability

ToSIA is now ready for use as a decision-support tool for your work. Now that the EFORWOOD project has been completed, ToSIA and its databases will be maintained for and developed further by a network of previous partners, future users and other interested parties, the ToSIA Management and User Group.

"ToSIA is a tool that can help politicians, government departments and other players to make sound and reliable decisions on forestry and the forest products industry leading to sustainable development.

EFORWOOD is one of the biggest ever forestry research projects in Europe. The budget for 2005–2010 (51 months) was €20 mio, with a €13 mio contribution from the European Commission. Thirty-eight partners from 21 countries contributed to the result."

Coordinator
KAJ ROSÉN
The Forestry Research Insitute of Sweden.
kaj.rosen@skogforsk.se

SUSTAINABLE DEVELOPMENT

Three dimensions

Sustainability has been the leading principle in forestry for centuries. The concept of sustainable forest management has evolved from sustained timber yield and steady forest cover to meet the demands from society for increasing diversity of goods, benefits and ecosystem services. This extended approach to sustainable forest management developed from the concept of sustainable development which was introduced in the Brundtland report in 1987.

After the UN Conference on Environment and Development in 1992 in Rio de Janeiro, sustainability became an issue in the political arena, and consequently, forests and forestry have been included in the international and national policy agendas. Concern about the sustainable use of forest ecosystems, e.g. regarding biodiversity and its economic and social contribution is an emerging issue for local communities and for a variety of other forest related stakeholders.

A joint vision for all is that sustainability should include the three dimensions; society, economy and environment.

Sustainability and the forest based sector

Among the other economic sectors, the forest sector sees itself as at the fore-front in sustainable development, using renewable natural resources as raw material and for energy. For instance, in relation to climate change and carbon sequestration, the forest sector is contributing in two ways – reducing carbon emissions, and increasing carbon sinks. Reducing carbon emissions has been justified by low embodied energy of wood as a building material, and indirectly, by substituting for energy-intensive materials with higher greenhouse gas emissions. Biomass growing in the forest is a natural carbon sink, until it decays in the forest, is burned, or releases its carbon content in landfills. Storing that biomass in buildings or other wood products contributes to the carbon storage. The European wood-based industry recognizes the importance of the sustainable 'triple bottom line', where long-term economic development must be balanced against the need to respect the environment and the interests of society as a whole.

There are various methods contributing to the sustainability assessment of the forest sector (see next page). However, none of these allows for quantitative sustainability impact assessments of the complete forest-based sector or parts thereof. To develop this was a main objective for EFORWOOD.

PHOTO:BIGSTOCK

Contact person
RISTO PÄIVINEN.
European Forest Institute,
Finland.
risto.paivinen@efi.int

PHOTO: ERIK VIKLUND

EXISTING APPROACHES TO ASSESS SUSTAINABILITY

The Ministerial Conference on the Protection of Forests in Europe (MCPFE) is the pan-European policy process for the sustainable management of the continent's forests. It develops common strategies for its 46 member countries and the European Union on how to protect and sustainably manage forests. Their report State of Europe's Forests 2007 is a comprehensive and up-to-date description of the situation and the management of European forests as well as the related policies and institutions 1. It shows the status and trends related to forests and sustainable forest management in Europe, structured according to the Pan-European Criteria and Indicators for Sustainable Forest Management, including, for the first time, qualitative indicators on policies and institutions.

A major achievement has been the development of criteria and indicators for sustainable forest management (SFM) by national and international governmental and non-governmental institutions to further "clarify what is meant by SFM in practice".

The Global Reporting Initiative (GRI) is a network-based organization that has pioneered the development of the world's most widely used sustainability reporting framework. GRI promotes and develops this standardized approach to reporting to stimulate demand for sustainability information – which will benefit reporting organizations and those who use report information alike. At European level, the CEPI's reporting of sector performance, based on GRI methods, assimilates information and aggregates data that companies and member organisations voluntarily provide, complemented by their own research.

The pathway analysis include the social and environmental costs of energy in Europe, calculated by following the pathway from source emissions via quality changes of air, soil and water to physical impacts.

The Sustainability Impact Assessment Tool (SIAT) was developed in the SENSOR project. SIAT relates policy changes to land- use changes and the subsequent impacts on sustainability. SIAT includes only forest resource management and does not consider the production chains downstream of a forest.

During the past decades **Life Cycle Assessment** (LCA) methodology has been continuously improved and widened in scope. LCA has gained increased acceptance and has been the most widely applied approach for studying environmental impacts of a wide range of production sectors.

Ecological footprint and **carbon footprint** assessments are methods closely related to and/or compatible with LCA, focusing also on environmental consequences of product consumption. Similarly, the Paper Scorecard proposed by WWF assesses environmental footprints of pulp and paper processing.

For further information see section "Read more".

PHOTO: ERIK VIKLUND

EFORWOOD provides the first tool for a quantitative sustainability impact assessment of the complete forest-based sector – or parts thereof.

THE EFORWOOD CONCEPT

Despite extensive discussions on the sustainability paradigm, the concept is still not easy to grasp and there has been a lack of attempts to allow firm objective assessments in the forest-based sector.

The approach adopted in EFORWOOD does not assess sustainability of existing practices directly because it is virtually impossible to substantiate scientifically that a system or development path is sustainable, as we often lack clear targets and thresholds for sustainability indicators. For example, dead wood is a well recognized indicator of forest biodiversity, but it is impossible to specify distinct thresholds for dead wood volume below which a particular forest management system would turn unsustainable.

More practical is the impact assessment of changes in forest-wood chain variants on sustainability. The main idea for the sustainability impact assessment of the forest-wood chain in EFORWOOD is based on four basic concepts:

1. Forest-wood chains are described as chains of processes from the forest to the consumption and end of life of wood products

2. Sustainability impacts in the chain are assessed by analysing indicators of sustainability that characterize processes in the chain.

3. Overall sustainability is quantified by multiplying the relative sustainability indicator impacts of a production process by the amount of material that is handled in this production process.

4. Sustainability indicator results are then aggregated for segments or the whole chain.

Changes in policies, markets or technologies affect either the amount of material flow through the chain, the chain structure, the indicator values given for the processes, or combinations of all of these. By aggregating the sustainability indicator results along the chain it is possible to assess the total impacts of alternative policies or technologies on sustainability.

A forest wood chain is composed of processes from forest regeneration to the consumption and end-of life of wood products. In EFORWOOD the different parts of the forest wood chain are handled i Module 2 - Forest Resource Management, Module 3 - Forest to Industry interactions, Module 4 - Processing and Manufacturing and Module 5 - Industry to Consumer Interactions.

PHOTO: MATTIAS WESTERBERG/SKOGENBILD

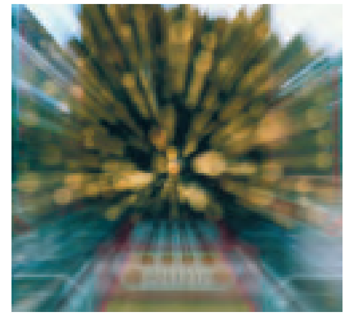


PHOTO: STEFAN ÖRTENBLAD/SKOGENBILD

PHOTO: BJÖRN SVENSSON/SKOGENBILD

PHOTO: STEFAN ÖRTENBLAD/SKOGENBILD

The indicator framework

A team of social scientists with experience in indicator development were tasked with implementing and coordinating the EFORWOOD indicator development process that followed a number of iterative steps. While indicators of sustainable forest management had already been introduced by the Ministerial Conference on the Protection of Forests in Europe (MCPFE), commonly agreed sustainability indicators were lacking for the rest of the forest value chain. The general requirement for the indicator set was that it should be consistent with other sustainability indicator frameworks developed in Europe and beyond. It should also provide a basis for international and inter-sectoral comparisons. Estimates confined only to the forest-based sector are of limited use for policy-makers at higher than sectoral levels, therefore indicators selected needed to be easily understandable even to non forest-wood-chain experts. Moreover, the indicator set needed to address all major sustainability impact dimensions as well as indicator demands of multiple user groups, including policy makers.

During the development of the framework, input from partners and stakeholders was requested to be based on four selection criteria, two were science-oriented (indicator relevance, technical feasibility) and two practice-oriented (data availability, cost of indicator application).

The initial indicator framework was also used as a starting point for developing operational specifications of the indicators aimed to assist data collection, test chain developments and provide a basis for the EFORWOOD sustainability impact assessment.

Experiences at all stages from indicator development, data collection and data use in impact assessment models, were systematically included in the design of a process to further develop and revise the indicator set. This process underwent three rounds of testing and revision before a final set of indicators was produced. This set now represents a thoroughly tested indicator framework.

The final set of main EFORWOOD sustainability indicators is presented in the table below. Each of these indicators may consist of several sub-indicators. For example the proportions of male and female employment are sub-indicators of the main indicator employment.

THE SUSTAINABILITY INDICATORS USED IN EFORWOOD AND ToSIA

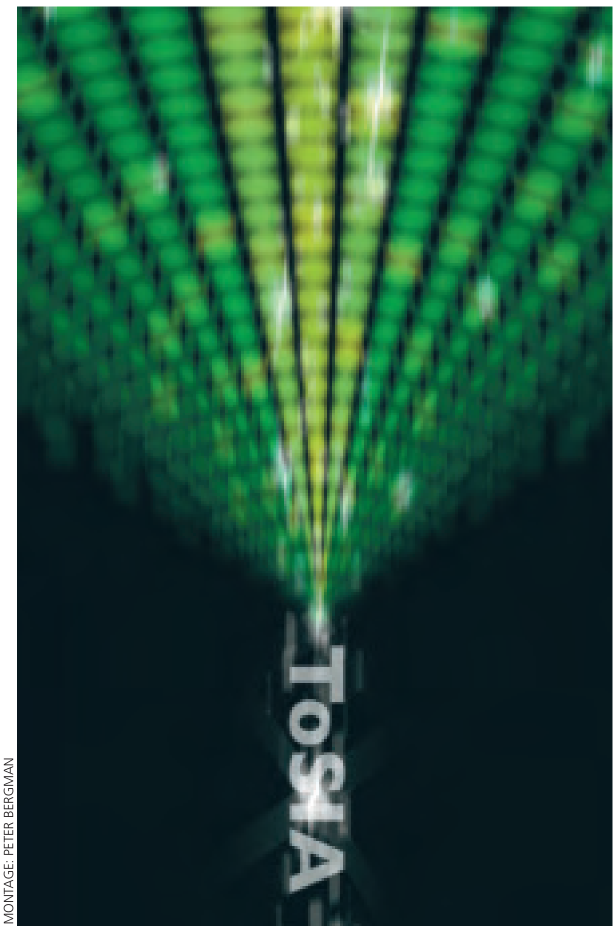
Economic	Social	Environmental
Investment and R&D	Education and Training	Forest biodiversity
Gross value added	Innovation	Energy generation and use
Resource use	Employment	Water and air pollution
Total Production	Occupational safety and health	Generation of waste
Trade Balance	Consumer behaviour and attitude	Forest damage
Enterprise structure	Corporate social responsibility	Greenhouse gas emissions and carbon stock
Labour Productivity	Provision of public forest services	Forest resources
Production costs	Wages and salaries	Soil condition
		Transport
		Water use

Contact person
MARCUS LINDNER.
European Forest Institute,
Finland.
marcus.lindner@efi.int

THE TOSIA TOOLBOX

The ToSIA toolbox consists of several components:

- **Data collection protocol**
- **Data client and EFORWOOD database**
- **ToSIA calculator**
- **Evaluation tools and a database for policy analysis**

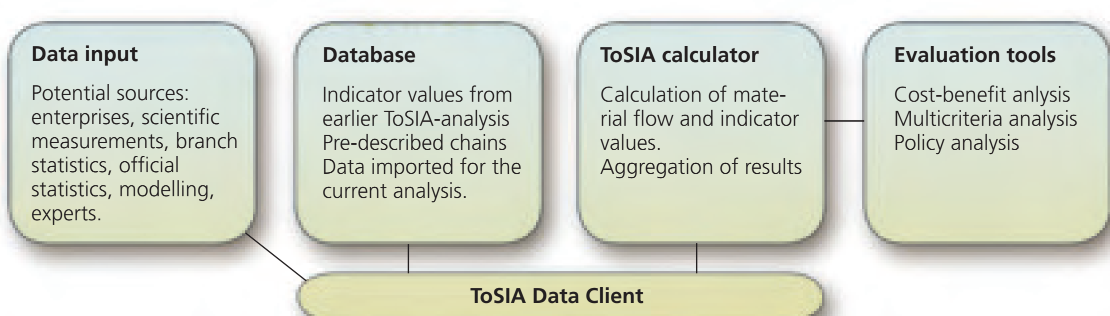


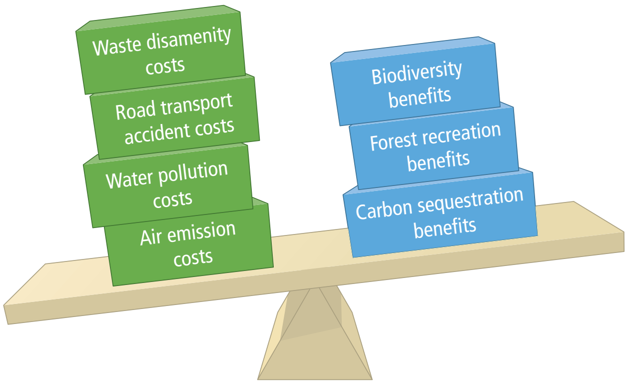
MONTAGE: PETER BERGMAN

Data collection protocol

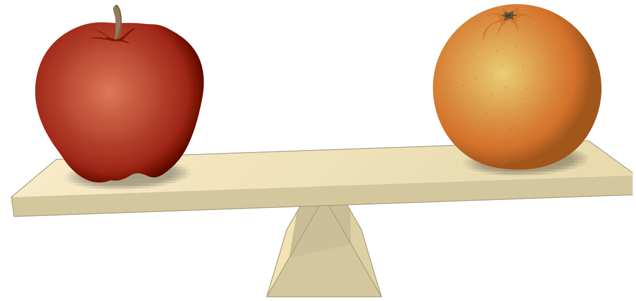
Good quality data are the key for a reliable sustainability impact assessment. To implement and simplify the collection of data and to assure data quality in ToSIA analyses, data collectors need to rely on a manual called 'Data Collection Protocol'. For each of the sustainability indicators the manual gives a thorough description and detailed explanation of where to find and how to calculate the indicator values needed for sustainability impact assessment.

For each indicator and its sub-indicators, the measurement unit, system boundaries, possible data sources, as well as key definitions are given. Key to the data collection protocol are practical examples on how to derive and calculate indicator values. These explain in a comprehensive manner what data collectors have to take into account before the indicator values are submitted.





Cost-benefit analysis balances monetary costs and benefits, taking into account external costs and product prices and discounting them to represent present values.



With multi-criteria analysis you have the possibility to compare indicators of different measuring units. MCA also gives you the possibility to weigh the importance of different indicators and to rank results.

The data client and the database

All EFORWOOD data are stored in the central database. A software called EFORWOOD Data Client allows the user to access contents of the database using hierarchically organized forms and overview tables.

The client also contains the chain editor, which enables the users to design chains visually using graphical representation of processes and their interconnections. The authorized users can also use the client to obtain the complete content of the database.

There can be several forest-wood-chains in one database. One chain is then processed in ToSIA as a whole. All processes and products from all chains are available in the database; this way available indicator values and conversion factors can be reused.

The ToSIA calculator

The user selects a forestry-wood chain and relevant chain alternatives from the data base and transfers them into the ToSIA calculator. Material flows for the processes in the chain are calculated and ToSIA combines them with quantifed environmental, economic, and social indicators. The indicator results for each process can then be aggregated for segments or for the entire chain.

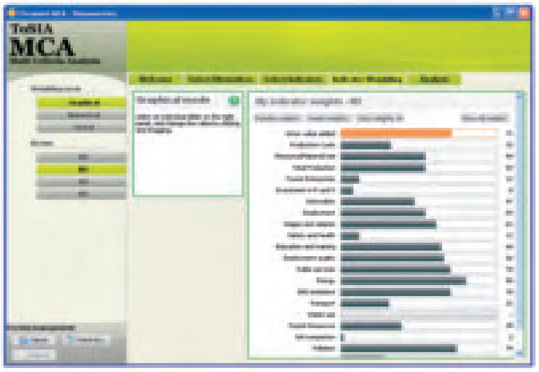
The calculation procedure is repeated for one or several ”what-if ” alternatives, and the differences between alternatives with regard to selected sustainability indicators are presented.

Evaluation tools

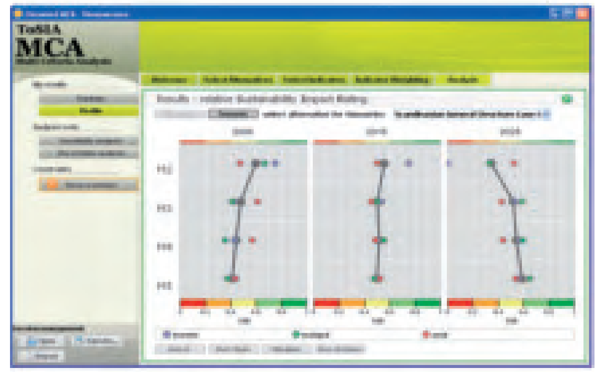
Comparing the impacts of policies or management systems indicator by indicator does not provide a holistic overall result. To evaluate whether the overall impacts are high or low, evaluation methods are needed. For this purpose, two commonly used methods have been implemented in EFORWOOD: cost-benefit analysis (CBA) and multi-criteria analysis (MCA). Both work on the basis of weighting, evaluating and aggregating multiple indicators to one comparable measure. As a third option for interpretation of ToSIA results, a policy analysis interface will be incorporated into ToSIA.

Cost-benefit analysis

Cost-benefit analysis is a decision-support tool rooted in neoclassical economic theory. It compares benefits and costs associated with an investment project or a policy. Benefits and costs are defined as increments and decrements of human wellbeing (or welfare, or utility), and are measured in monetary terms taking individual preferences as the source of value. A project or a policy passes a cost-benefit test if social gains exceed social costs measured in terms of their net present value.



In the multi-criteria analysis, users can assign different weights to each indicator, using either numerical values between 1 and 9, verbal statements (e.g. low or high importance) or by shifting a ruler in the graphical mode as shown here.



The results are displayed as relative sustainability ratings with sustainability profiles along the modules in the forestry- wood chain. The three sustainability pillars can be displayed in colour in addition to the average value. As a synthesis value an overall sustainability impact rating can be calculated as an aggregated value for the whole chain.

A tool for cost-benefit analysis is implemented within the ToSIA software. It allows for a choice of a discount rate and for customizing net present value calculations based on the monetary values attached to external effects and product prices in a chosen combination of chains, scenarios and reference futures. In a sensitivity analysis, the robustness of conclusions drawn from net value based rankings can be checked.

Multi-criteria analysis

Multi-criteria analysis is a bottom-up tool based on decision theory and strongly coincides with post-modern economics. It introduces subjective value systems into the decision-making process and facilitates the participatory involvement of selected public representatives and stakeholders. The aggregation measure is a cumulative preference ranking of alternatives by a single decision-maker or a group of stakeholders.

Multi-criteria analysis is implemented as a separate software tool that is linked to ToSIA via a data interface. It facilitates the selection of indicators, their specification for a specific decision problem via thresholds and weighting of indicators with regard to their importance for a sustainability impact analysis.

The analysis part provides relative sustainability impact ratings (i.e., an aggregated dimensionless index representing the relative preferences for a set of alternatives) for individual segments of the forestry wood chain (i.e. forestry, transport, industrial production, trade) or for the entire chain. Sensitivity analysis informs about the effects of changing weights on the overall rating. Uncertainty analysis allows judging the impact on the assessment result arising from uncertain input data.

PHOTO: BIGSTOCK

PHOTO: EU

The EU Commission stands for a majority of the policy documents that affect the sector.

Policy analysis

Developing a policy analysis interface for ToSIA required the assembly of a policy database that included all European and international legislative and policy documents (up until 2009) relevant to EFORWOOD sustainability indicators. Data pertaining to legislative and policy documents, was collected by identifying and analysing relevant documents, for example from the EUROLEX database or individual homepages of relevant General Directorates of the European Union. Documents generated in the European (e.g. Ministerial Conference on the Protection of Forests in Europe) and international context (e.g. United Nations Forum on Forests) were also analysed and included in the database if considered relevant.

All documents were analysed with a view to determining quantitative and qualitative thresholds that relate to the sustainability indicators. The Policy database compiles the policy documents, lists the EFORWOOD sustainability indicators which are addressed (so called indicator use) and presents all relevant targets and thresholds specified by the policy documents.

The database includes 235 policy documents, out of which roughly three quarters are laws and policies issued by the European Union. It was found that the dimensions of sustainability are unevenly regulated in Europe. Of the ten EFORWOOD sustainability indicators referred to more than 20 times in the policy documents, no less than seven belong to the environmental dimension.

To link the policy targets with the ToSIA results, the direction of change advocated by the policy is specified as “maintain”, “increase” or “decrease”. Targets and thresholds, as defined by the available legislative and policy documents, provide the framework for an analysis of the directions of change in ToSIA indicator values as related to defined policy targets. Results from this analysis will be available as a more extensive policy analysis section within the ToSIA tool. The EFORWOOD policy database will also be made available for other users.

Contact person
MARCUS LINDNER.
European Forest Institute,
Finland.
marcus.lindner@efi.int

"In ToSIA the sustainability indicators of an activity are compared with a reference future. EFORWOOD has specified two alternative reference futures: with high economic growth and continued globalization or with lower economic development and more local economy".

REFERENCE FUTURES

By 2050 the world will have changed in ways that are difficult to imagine – as difficult as it would have been at the end of the 19th century to imagine the changes of the following 100 years. Scenarios that are based on contrasting storylines can be used as a tool to explore the different ways in which the future may develop and asses their impacts on the sustainability of the European forestry wood chain. Each storyline assumes a distinctly different direction for future developments, and does not necessarily aim to be realistic.

Scenarios are neither predictions nor forecasts, but are used to create a consistent image of a future. A set of scenarios aims to describe divergent futures that encompass a significant portion of the underlying uncertainties in the main driving forces. These drivers cover a wide range of key characteristics such as demographic change, economic development, and technological change. For this reason, their plausibility or feasibility should not be considered solely on the basis of an extrapolation of current economic, technological, and social trends and no conclusions should be drawn from these storylines directly. They are not agreed views of the EFORWOOD consortium on how the future of European forests and the forest industry would or should be.

Because driving forces can take different directions, it is good practice to develop multiple baseline scenarios. For scenarios with a relatively short time horizon usually two baseline scenarios at opposite extremes of the spectrum of outcomes are sufficient. In EFORWOOD it was therefore decided to focus on two baseline scenarios. These are called the reference futures.

The IPCC (Intergovernmental Panel on Climate Change) has developed a set of emission scenarios (SRES scenarios). These were mostly developed for energy system parameters and related emissions, but the underlying reference futures also provide consistent storylines on the development of key drivers like population growth, economic development and energy prices in the future.

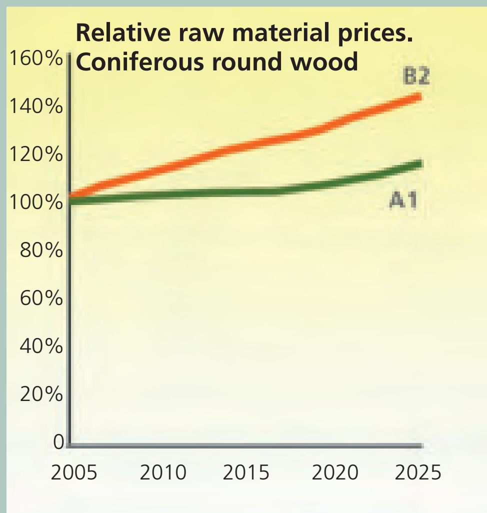
The reference futures applied within EFORWOOD were based on development of such key drivers for the two contrasting A1 and B2 storylines from IPCC's SRES scenarios. Additionally specific forestry-wood-chain aspects were further elaborated and then quantified using different literature sources and a combination of a forest growth and management model (EFISCEN) and a forest products trade model (EFI-GTM) to determine forest stand developments, wood demand, harvest and prices for various raw materials.

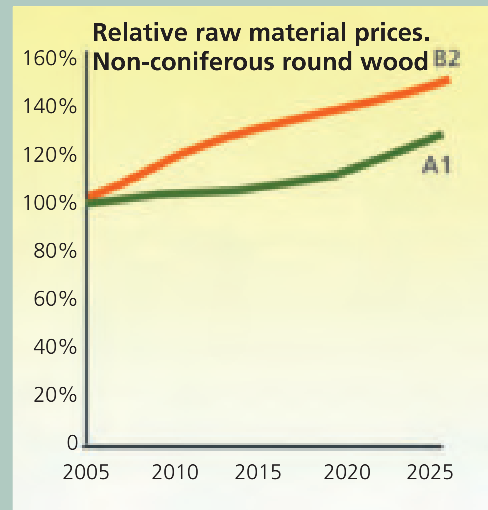
In the EFORWOOD project the situation in 2005 is assesed and possible future developments for 2015 and 2025 projected with the A1/B2 scenarios.

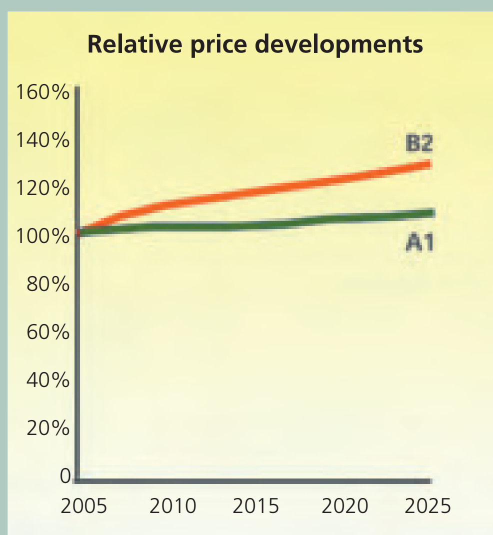
What if-questions

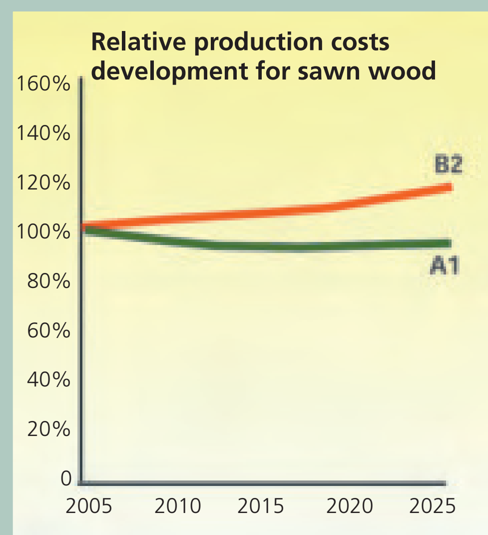
Reference futures are "benchmark" scenarios with dynamics, but without major interventions. Subsequent comparison with the actual scenarios then enables the assessment of the effect the scenario drivers will have. Therefore, in the four EFORWOOD case studies, on top of the reference futures, scenarios on changes in technology, consumption patterns, bio-energy use and nature conservation policies were applied. These scenarios were intended to answer 'what if ' questions. Ideally such scenarios are applied on top of both the reference futures in order to be able to assess the level of uncertainty related to future developments. Due to time and data limitations not all scenarios were applied to both reference futures.

A1 and B2 implemented in Eforwood - examples









A1 AND B2, THE TWO REFERENCE FUTURES

A1 reference future describes a world of very rapid economic growth with a global population that peaks in mid-century and declines thereafter, and shows rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in the regional differences in per capita income. In general the public awareness concerning environmental issues is low

B2 reference future describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population, intermediate levels of economic development, and less rapid and more diverse technological change than in the A1 storyline. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

Contact person
ERIC ARETS
Alterra,
The Netherlands
Eric.Arets@wur.nl

INTRODUCTION TO CASE STUDIES

ToSIA has been designed to be a flexible tool for sustainability impact assessment which can be applied to study Forest-wood chains at different scales. Forest practitioners look at the chains as driven by the forest and its management, whereas consumers may have a stronger connection to the wood products with only vague information of the value chain behind the product.

Single Forest-wood chains

The application of the EFORWOOD sustainability impact assessment methodology was first tested using simple chains which linked specific forest management types with selected wood products. The test chains were selected to represent different regional examples of forest wood chains in Europe, covering a range of different tree species as well as typical product value chains (solid wood, paper, and energy products).

The Single Forest-wood chains were also used to develop and test the first draft indicator framework. The gained experience helped to refine some concepts; but most importantly it lead to recognize how important concrete specification of data collection protocols was for conducting consistent sustainability impact assessments along complete value chains.

• **A Scots pine chain in Scandinavia** producing furniture and bio-energy. This chain had two branches that produced different wood products and it was used to develop a method of assigning sustainability indicator impacts to multiple products (for example, energy use in a harvesting process is partly allocated to the furniture, pellets and other side products of the chain).

• **A fine paper/newspaper chain including recycling.** The paper production located in Portugal utilized local Eucalypt and imported Kraft-pulp from Scandinavia. Furthermore, the paper recycling loop was used to test the material flow calculation in a complex forest wood chain topology.

• **A Norway spruce chain in Baden-Württemberg,** producing timber frame for house construction. This included two alternative Norway spruce management variants with natural regeneration in close-to-nature silviculture and planted regeneration in a clear- cut management system. These management alternatives were used to test the scenario assessment of chain variants.

Four case studies

Based on experiences with the simple forest-wood chains, four case studies were developed to demonstrate how the sustainability impact assessment can be conducted from different perspectives and for different geographical scales. For example, the impacts on sustainability of changing consumer habits can only be assed if the chain is calculated and analyzed from the consumer's point of view. For a forester, on the other hand, it is important that the sustainability impact assessment analyses the resource management part of the value chain in sufficient detail.

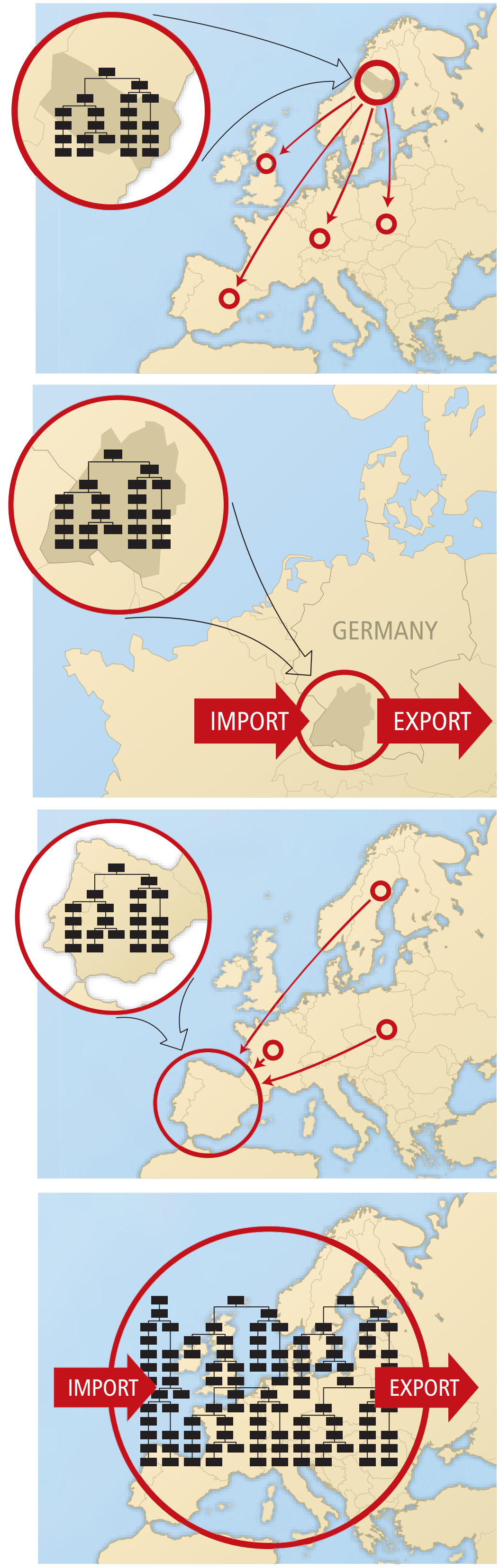
The four case studies in EFORWOOD were:

- **The Scandinavian case.** This was a forest-defined case and aimed to describe the network of Forest-wood chains originating from northern Sweden. Wood from forests in the area of Västerbotten was followed along the value chains from the resource to the end-users of the wood products in Europe.
- **The Baden-Württemberg case**. This was a regional- defined case and aimed to describe the network of Forest-wood chains in Baden-Württemberg including imports into the region and exports out of the region and cross-links between the different production lines of sawmilling, pulp & paper and the bioenergy sector.
- **The Iberian case.** This case was consumer-defined and described Forest-wood chains feeding the Iberian market for paper products.
- **The EU Forest Wood Chain.** This application aimed to describe the major Forest-wood chains at the European level including the trade flows between countries.

Data validation

Ensuring high quality and consistency of data has been a major ambition throughout the EFORWOOD project. It has been recognized that collecting a comprehensive and harmonized data set can be challenging. The following procedures were applied to improve data quality:

- The data collection in the four ToSIA applications had instructions in the form of a data collection protocol, in order to ensure consistent use of specified measurement units and calculation concepts.
- Completeness of datasets was frequently checked, and regular feed-back was given to data providers.
- Routines for consistency checking of the material flow data were implemented in the ToSIA calculator, to flag possible inconsistencies in the forest-wood chain parameters.
- The relative indicator values were evaluated using constraints based on the relationships between indicators and statistical tests performed in order to identify outlier values.
- Where available calculated material flows and indicator results were compared with independent statistical information to verify the calculations in ToSIA.



The four EFORWOOD case studies demonstrate different ways of applying ToSIA, with variable amount of detail in the different parts of the Forest-wood chain, depending on the geographical scope and the topical focus of the assessments.

Contact person
MARCUS LINDNER.
European Forest Institute,
Finland.
marcus.lindner@efi.int

The Scandinavian TECHNOLOGY CASE

"What if-question": What happens with the sustainability indicators if new technologies, e.g. the latest scanning devices, are introduced in the sawmills that are processing timber cut in the county of Västerbotten, Sweden?

New technology

It is important for the timber industry to radically improve its customer focus and orientation. This will be achieved through the production of products of increasing added value to meet end user requirements instead of standard bulk products. Value added wooden components include sawn timber products with specific quality requirements which are precisely defined by individual customers. Requirements may concern dimensions, knottiness, density, annual ring width etc. Adding greater value through lamination, re-engineering and upgrading durability are also significant opportunities. Components are typically used in the furniture and joinery industry and also in the construction sector. The value of components made to specific requirements can be up to three times higher than the price of conventional sawn timber.

Components are produced at the sawmills with sophisticated, flexible and adaptive manufacturing processes. These are supported by smart information and communication technologies at the designing and production planning stages and through-out the manufacturing processes. Increasing flexibility provides the possibility to switch the production from bulk products to value added products and vice versa depending on the wood product markets. Future manufacturing systems are also provided with self learning, adaptive features allowing better planning and quality of output as well as adjustment of processing parameters to improve efficiency. Supply chain and process efficiencies offer great opportunities to lower impacts for wood products.

A key element in the future manufacturing systems for solid wood industries is automated scanning for measuring and detection of wood properties including raw materials, semi finished and finished products, to allow on-line sorting and grading. Typically scanning is used. for measuring surface properties in order to classify them i.e. for wood veneers. Scanning of internal properties of logs and stems is progressing and will provide possibilities for improving value yield from the raw material. By the application of x-ray technologies it enables the output of sawn timber volumes and grades to be estimated before sawing operation. In current operations product output can be assessed only after sawing.

A number of marking and identification technologies are entering use in the wood industries. These technologies provide the possibility to store data in large data bases throughout the whole conversion chain from the forest to end products. As a result of marking individual pieces, integration of the data into an information chain is achievable. This enables source tracing of the final products in relation to the corresponding logs and original forest area. These types of company "global" information system strongly supports the development of sustainable business opportunities.

The case-study in Scandinavia takes into account advanced techniques that improve timber use efficiency and production flexibility of saw-mills with particular reference to four new technologies:

1. Devices for scanning the internal properties of stems and logs so as to optimize sawing operations. Implementation of this technology will help in optimizing the quality of the sawn timber products.
2. Measuring systems for characterization and grading of sawn timber as well as supporting secondary conversion.

PHOTO: STEFAN ÖRTENBLAD/SKOGENBILD

The study area

The county of Västerbotten is located in northern Sweden. It is a sparsely populated area dominated by extensive forests, covering more than 3 million hectares. The annual harvest in 2005 was 7 819 000 m^3ob. Approximately 30% of the volume came from thinnings

3.Information recording and intelligent material flow control making it possible to track the origin of the raw material and ensure the correlation of information relevant to processing, manufacturing and retail of the products.

4.Flexible and adaptive manufacturing systems for sawmills to provide value adding technology for upgrading sawn timber and production of components.

These new technologies lead to many sometimes conflicting impacts. Whilst they can reduce the amount of sawdust and waste produced in the milling process, as a result the flow of by- products as sources for the paper, pulp and panel industries will be reduced.

Increased flexibility of production of sawn wood increases the quality of products that are better tailored to consumers needs. However other impacts of the increase in value added include increased costs and the production of smaller, consumer oriented batches of sawn timber will result in increased transportation costs. The increased automation of the production process decreases the manpower needed, but also decreases occupational health risks.

The ToSIA process

In order to provide the basis for the ToSIA process the following activities were carried out:

• The present status of the forests in the county of Västerbotten in the base line year 2005 was described.

• Harvesting operations and transport of timber from the woods to the industries were described.

• The processing and the end products were defined, e.g. wooden houses, gluelam, windows, furniture, planed goods, particleboards, plywood, sawn wood, pellets, and bio energy.

• Model mills instead of real mills were used for the calculations. Timber logs were handled through two different sizes of sawmills (150 000 and 50 000 m3/ yr), and all pulp wood went to one integrated fine paper mill (85 000 tonnes/yr) and one kraftliner mill (290 000 tonnes/ yr). Furthermore, the pellet production for energy (80 000 tonnes/yr) within the chain was also described.

• The wood chain ended with three product groups, i.e. solid wood products, paper products and bioenergy. The distribution of the products from the producer to the end user, the use of the products, the recovery and the end of life was described.

Data acquisition

Data from a number of different sources was used, such as National Forest Inventory (NFI), which provided data on the forests in Västerbotten, follow up routines from enterprises, data from experiments or scientific measurements, and branch statistics, e.g. energy consumption CO2-emissions and fertilization costs.

Official statistics were used for costs, wages and salaries.

Forest growth and yield data, harvest costs and time for reference futures 2015, 2025 were defined using models and experts judgements.

Assumptions

In the ToSIA analyses, it was assumed that the demand for wood products would remain unchanged compared to the baseline but since the new technology increases the efficiency of material use, this demand can be met with a reduced amount of sawn timber. Due to this, and the decreased amount of by-products from sawmilling (sawdust, chips), the pellet-, particle board, and pulp mills would receive less raw materials from this source and must look for other sources to meet their demands of pulp, paper and pellet products.

Result of x-ray log scanning.
From: VTT 2009

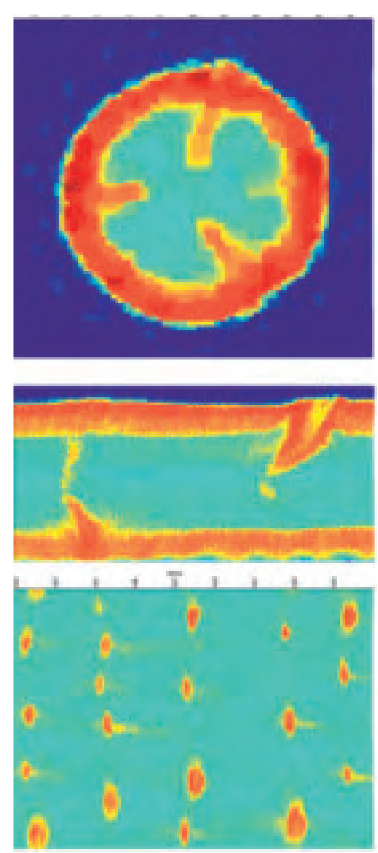


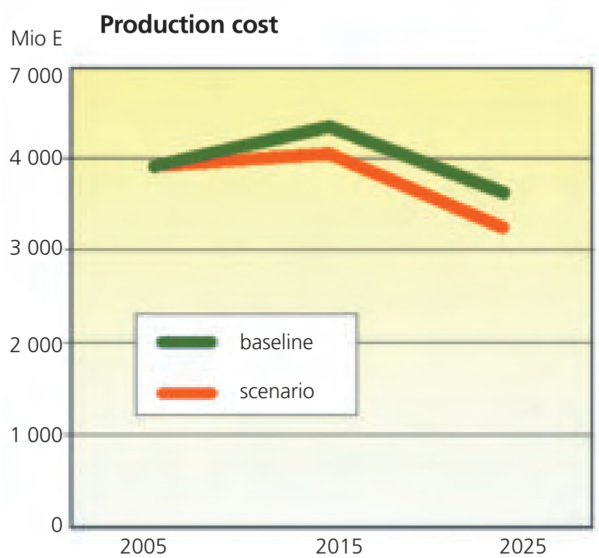
FOTO: THOMAS ADOLFSÉN/SKOGENBILD

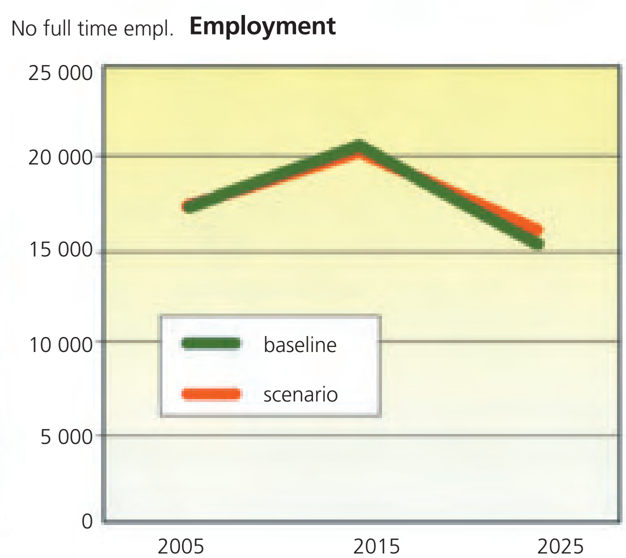
Results – examples

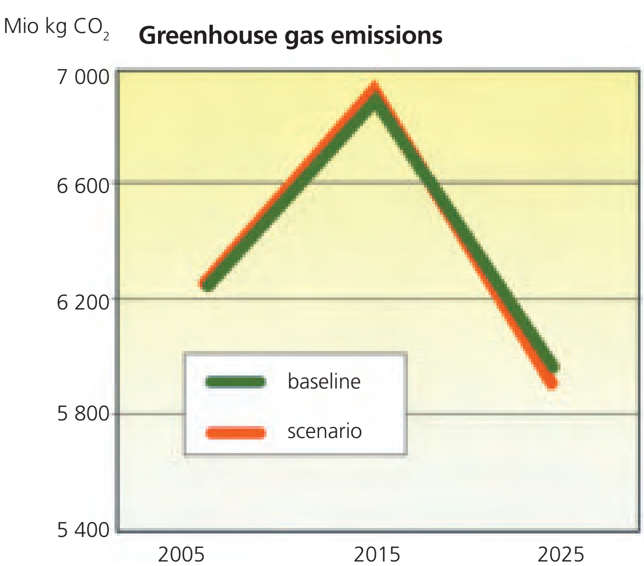
The charts below summarise some main preliminary results from the case study. The green lines illustrate the development of the baseline scenario from 2005 to 2025 for the three indicators chosen, the red lines the predicted outcome when the new technologies are implemented.

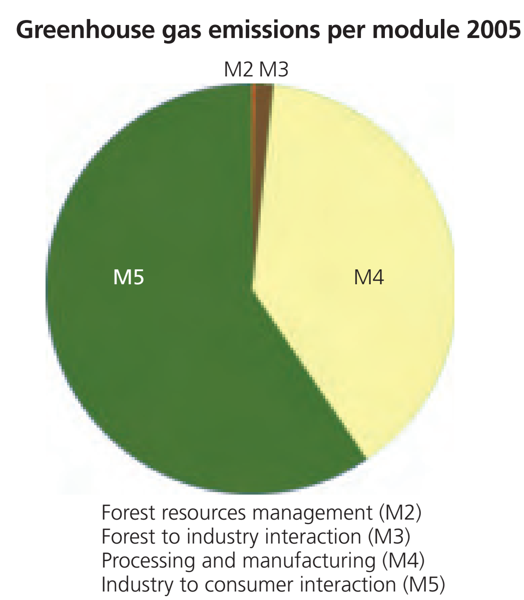
The results indicate small changes, which can depend on the rather high level of technology already present in 2005.

ToSIA can present the results in various ways to facilitate interpretations. Results for a given indicator for the whole chain can be presented as in the three figures below. Furthermore, for each indicator a pie-chart can indicate the proportion of the indicator for each of the four modules. This make it possible to determine the parts of the chain that are most important to focus on for a given indicator. In this case study, industrial production and end-user interaction is totally dominating the greenhouse gas emissions. The forestry and the transportation of the wood to the mills have almost no impact (see pie chart below)..









Contact person
ERIK VALINGER
Swedish University of Agricultural Sciences, Sweden
erik.valinger@ssko.slu.se

The study area
Baden-Württemberg is located in the south- west of Germany with political borders to France and Switzerland. 1.4 mio ha, or 38% of the total area, are afforested with a large variation of softwood or hardwood dominated forests or species mixture in different age classes. Annual harvest is approximately 9.1 mio m^3 round wood (ub) for hardwood and softwood.

The Baden-Württemberg BIOENERGY CASE

"What if-question": How do the sustainability indicators "gross value added", "production costs", "employment", "greenhouse gas emission" and "transport distance of products" change, if more woody biomass from the forest is used for bio-energy production in the federal state of Baden-Württemberg?

Bioenergy scenario

In the case study we investigated the effects of increased use of woody biomass for bio-energy production from forest and other resources in Baden-Württemberg. This scenario included the following considerations:

• The increased use of harvesting residues from the forest.
• The harvesting of stumps which is not a usual operation in Baden-Württemberg except for selected cases, i.e. after wind blow.
• The consideration of biomass from short rotation plantations.
• The increase of wood pellets in production and consumption.

The Tosia process/ The value chain

• **Forest management**. The processes describing the status of the forests in Baden-Württemberg are defined on the base line year 2005.

• **Forestry to industry interaction**. Processes describing felling, logging and transport operations to the stage of arrival of the round wood at the processing industry ("mill gate") reflect the most common technology applied in Baden-Württemberg.

• **Processing and manufacturing:** Primary conversion and value-added production were defined for the three wood-based sectors sawmilling, pulp and paper production and bio- energy. An approach of generalising model mills was applied for the calculations; four different sawmill types (softwood mill: > 150 000m^3, 50 000–150 000 m^3, < 50 000 m^3; hardwood mill), a pellet mill, panel mill, and model mills for integrated newsprint production, integrated magazine paper production and carton board represent the typical technologies installed in Central Europe. For manufacturing processes a distinction was made between industrial production and small-scale manufacturing. The product lines refer to construction (product: "wooden house"), joinery (product: "windows") and furniture production (product: "kitchen").

• **Industry to consumer interaction.** The products defined pass through processes representing the different stages of "distribution/retail", "use", "collection", "recycling" and to the end of life "final thermal use". Production of energy is represented by heating systems of two different scales (home scale, small scale) and wood-based power production either coupled as CHP or pure PP systems.

Data acquisition

Data of different origin were used:

• Specific and empirical data such as National Inventory data (BWI 1 and BWI 2) on the forests in Baden-Württemberg, data from experiments or scientific measurements.

• Generic and derived data: e.g. branch statistics and official statistics. The data were modified for the case study by scaling and weighting in order to be applicable to the actual case.

• Model-based and estimated data calculations, e.g. for forest growth and yield data, harvest and transport costs, were performed using models and expert judgement. The forward projection for the development of the forest-wood chains was defined for each of the reference futures using the EFI-GTM model.

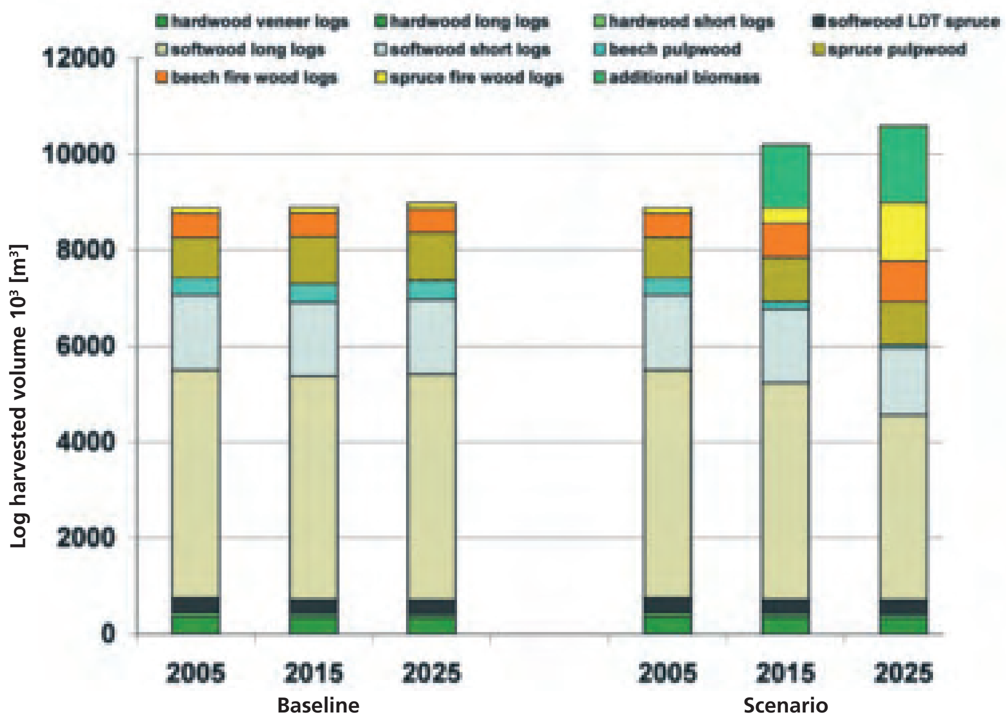


Figure 1. Harvested volumes in Baden Württemberg for reference futures (A1) and the bio-energy scenarios.

However, even the use of all three data collection options described above did not ensure complete procurement of indicator data for all processes identified.

Assumptions

In the ToSIA analysis it was assumed that the overall economic and demographic development of the study area will follow the trends as described for the A1 reference future by IPCC. Applying these trends to EFI-GTM, future production and demand for wood based products were predicted. Production and use of additional woody biomass from the forest and plantations were defined accordingly.

As overall production was assumed as constant, a change in use of biomass resulted in both a change of volumes between assortments, and in different allocation pathways of wood-based products through the value-chains. When input volumes into a process were not completely covered from production with in the region, the differences were assumed to be supplemented by imports.

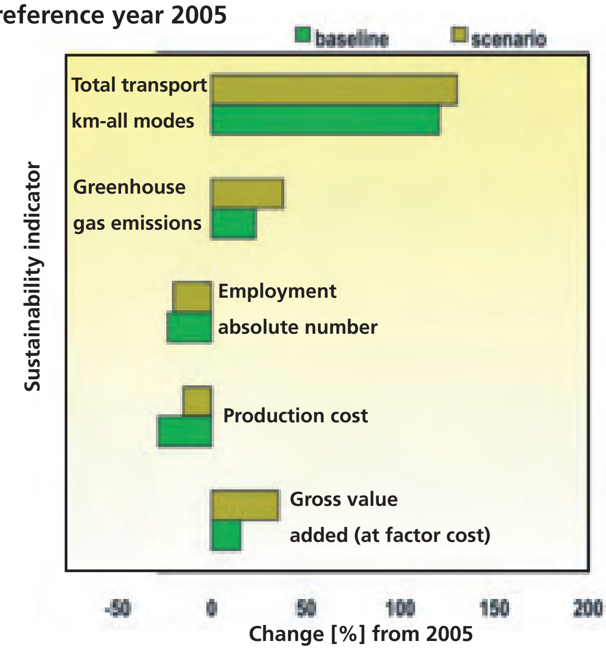
Results

Figure 1 illustrates the changes in wood volume between the baselane and the bio-energy scenario assumed. The analysis allows a quantification of changes in the volume of products with respect to the time development and the scenario.

Based on preliminary analysis of ToSIA calculation for partial value chains of the stages forest management and forest to industry interaction, changes in selected indicators for the forestry- wood-chain can be presented as shown in Figure 2. The results are very much affected by the amount of material flow, i.e. the wood volume considered in the system. Each indicator is calculated as the product of material flow and a normalised indicator value of the individual processes. Consequently, the values of aggregated indicators increase with the increase of material flow. Furthermore, changes in reference futures and scenario are very much affected by underlying assumptions as e.g. an increasing use of biofuel or an increase in efficiency.

Further analysis is required for final interpretation of these results. On the basis of changes in all phases of the forestry-wood-chain such as forest management, forestry to industry interaction, industrial production and consumption, or considering individual partial value chains in specific stages of the forest-wood chain.

Relative change between 2015 and reference year 2005



Relative change between 2025 and reference year 2005

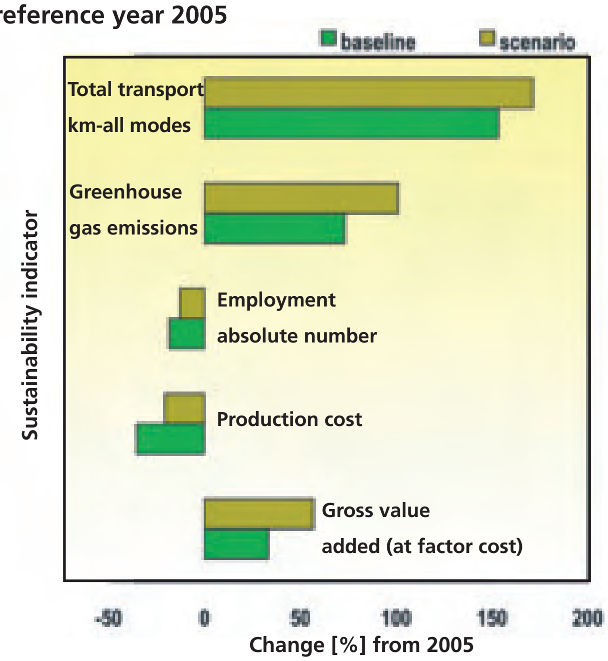


Figure 2. Relative changes of key indicators between baseline future and scenario against the reference year 2005 aggregating forest management and forest to industry interaction.

Contact person
FRANKA BRÜCHERT
Forest Research Institute Baden-Württemberg
Germany
franka.bruechert@forst.bwl.de

The Iberian CONSUMPTION DRIVEN CASE

”What if-question”: What happens with sustainability if consumption of fine paper and/or newsprint decreases or increases?

Consumers have significant influence on market evolution. Although there are several fragmented consumer groups, who have different drivers and values, it is clear that at least for some of the groups, one of the key driving forces for choosing a product is sustainability. As consumers take sustainability into account in their purchasing decisions, more clear and credible information about sustainability characteristics of the product is needed, and consequently market-oriented sustainability assessment tools is required to generate this information.

This forms the background to the Iberian case study. It was designed to test and demonstrate the capability of the ToSIA tool in a market-oriented mode.

Iberian Case study - a market driven case

The main objective of the study was to test ToSIA from a market perspective. This analysis had its starting point at the downstream final link of the chain – the consumer – and worked backwards through the previous stages in direction of the forest, the origin of the raw-material. The selected FWC products belong to product groups as being wood based, fibre-based, and bio energy products.

The lack of data - a structural difficulty

Distribution and consumption of wood-based products suffers from a serious lack of data needed for sustainability impact assessment. This lack is structural, and corresponds to the fragmented and heterogeneous wood working sector. Small companies do not necessarily collect or communicate data which are related to their production. The players in distribution and marketing are extremely numerous, and represent many sectors and materials beyond sole use of timber.

An experience from the development of the Iberian case study is that data exclusively related to the wood-based parts of final consumer products are not reported. The downstream products are in the statistical data defined as functional units (windows, doors, furniture, etc) or tons of products. The amount of wood per unit varies greatly and is very difficult to estimate. To be able to make a sustainability impact assessment, using ToSIA, these data are needed. Lack of such data led to a decision that the analysis of the Iberian case study was limited to paper products, excluding wood-based and bio-energy products

Preliminary experiences

The modelling of flows from consumption of paper products to production of biomass raw- material in the forest was the major objective of this case. The “what-if ” if questions included scenarios where impacts of changes in consumption of paper products was studied.

In conclusion, the preliminary, first results from this market driven case highlights possibilities and limitations of the present version of ToSIA. Despite that the original scope was reduced, focusing only paper products, the initial analyses shows the ability of ToSIA to, for example, assess the sustainability impact of an increase or decrease in consumption of fine-/office paper and newsprint. Another experience is that further development of the ToSIA software is needed in order to account for recycling and reuse of materials after consumption in a correct way.

Contact person
LUDOVIC GUINARD
Institut Technologique
FCBA, France.
ludovic.guinard@fcba.fr

PHOTO: MATTON IMAGES


PHOTO: ROYALTY-FREE/CORBIS

THE EU CASE

"What-if question" - What happens with sustainability if the forest area designated for nature conservation in the EU is 25% by 2025 instead of the current 9.4%.

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Introduction

Assessing sustainability impacts of strengthened nature conservation policy on the Forest-wood chain at the European level was the widest application undertaken within the EFORWOOD project. It aimed to describe the total aggregated chain at a European level, based on the most important chains in 27 countries (EU-25 + Norway and Switzerland) and to study the effects of increased Natura2000 protection on sustainability.

Topology. To set up the topology of the European Forest-wood chain, national-level templates of the most important chains were defined for country-groups. These were later adapted to better reflect individual country characteristics. Indicator information was also collected for the country groups, but adjustments were made for example to represent differences in salary levels between neighboring countries.

Trade. Incorporating trade between countries proved to be particularly challenging. Products are widely traded between European countries, leading to a huge number of possible connections between national Forest-wood chains. Trade flows between countries were captured in a simplified way by the introduction of import/export buckets for 6 product groups:

- Roundwood
- Primary conversion wood products
- Secondary conversion wood products
- Paper/board
- Pulp
- (Bio-)Energy

The information about the exports and imports from each country to/from the import/export buckets have been derived using bilateral trade data from EUROSTAT for the respective goods represented in the EU-Forest-wood chain. Average import and export distances (km) per country for all three transport modes (road, rail, water) and the 6 bucket product groups for all EU25+2 countries were estimated. These estimates were based on compiled NACE-classifications per bucket groups and served as input to connected import or export transport processes.

Imports from outside the EU are only tracked as soon as they appear inside the EU-borders. Imported wood is thus not pre- loaded with any indicator values for e.g. greenhouse gas emissions or transportation costs outside Europe.

The Tosia Process/ Data acquisition and quality

Although the presentation of processes was simplified compared to the regional case studies, the structure of the European Forest-wood chain and its sheer size resulted in huge data needs.

To maximise transparency, data from public statistics such as EUROSTAT were used whenever available. However, data coverage was incomplete and several models and educated guesses from experts had to be used to fill data gaps.

The validity of the data was tested on different levels. Tests were carried out to check the completeness of data. Data verification focused mainly on the data for 2005. Calculated indicator results were analysed in detail for the "Forest resource management"-module (M2) and "Forest to industry interactions"-module (M3), which were most affected by the Natura 2000 Scenarios.)

Scenario analysis

In the European case, the effect of increasing the forest area designated to nature conservation from the current 9.4% (according to MCPFE classification) to 25% by 2025 was studied. Each scenario was studied against the background of the global developments as outlined in the A1 (high growth) and B2 (low growth) IPCC scenarios (EFORWOOD reference futures).

Data for the future EU-FWC was generated by using the global wood-products trade model EFI-GTM and the forest resource model EFISCEN. The A1 reference future was implemented by removing trade barriers in the EFI-GTM model to represent increasing globalization. To reflect increased regionalization in the B2 reference future, trade barriers around Europe were increased in the EFI-GTM model.

Increased environmental awareness was reflected in the EFISCEN model by longer rotation lengths in conservation areas, an active shift from conifers to broadleaved tree species and the collection of harvest residues for bio-energy purposes. Increased nature designation levels were simulated by increasing the area with no or nature conservation-oriented management, and decreasing the area with regular forest management.

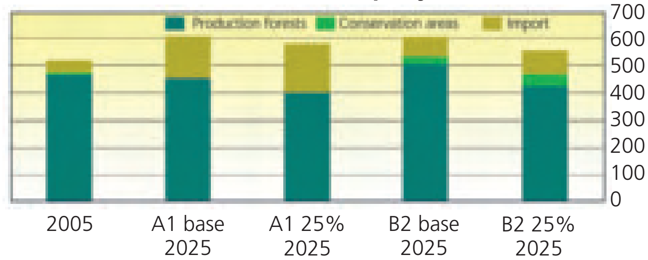
Results

Under the A1 reference future, wood consumption was increasingly met by imports from outside the EU, up to 30% under the increased nature conservation scenario. No wood was harvested in A1 in nature conservation areas due to the relative high costs as compared to imports. Under the B2 reference future imports decline to 11–14% of total consumption, while wood harvested from nature conservation areas represented a share of 5–9%. The overall decrease in wood consumption between A1 and B2 ranges from 3.2 to 8.5%.

Conservation effects on forest age structure

Measuring direct effects of the scenarios on biodiversity is not possible. However, the presence of some key forest species depends on old and undisturbed forest, and thus the proportion of old forests can give some indication of possible biodiversity effects. The highest proportion of old forest (>120 years of age) is reached under the nature conservation scenario in combination with reference future A1, due to the creation of large unmanaged areas. The lowest proportion of old forests can be found under the B2 reference future with no expansion of nature conservation area. This can be explained by the fact that even in the nature conservation area, harvest is needed and allowed in order to fulfill the demand for roundwood.

Consumed wood, million m³ob per year

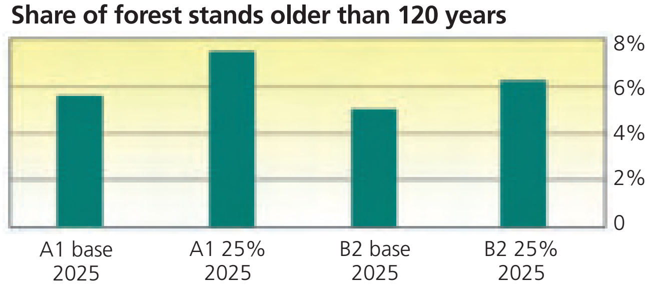


Origin of consumed wood in 2005 and 2025 under the A1 and B2 reference future and the current (base) and increased nature conservation (25%) scenarios.
"Production forests" is wood from forests not designated for nature conservation. "Imported" is wood from outside the EU.

Import can compensate most of harvest blocked by conservation – but not all

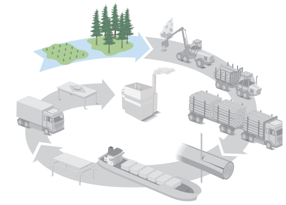
To obtain a similar proportion of old forest under the B2 reference future, additional conservation area is needed. This example shows that the impact of a certain policy scenario depends very much on global developments. Under increased globalization, the harvesting pressure on the forest is relatively modest, and without additional measures, biodiversity (as expressed by the proportion of old forest) can be maintained. However, if the pressure on the forest increases (in this case due to a shift in supply from import to conservation areas), additional measures are needed to safeguard biodiversity values.

Share of forest stands older than 120 years



Relative change in the different conservation scenarios 2025 compared to the baseline 2005. Source: EFISCEN, EFI-GTM

Contact person
DIANA VÖTTER
European Forest Institute,
Finland.
diana.votter@efi.int



FOREST RESOURCE MANAGEMENT

MODULE 2

In the context of the sustainability of the whole forest-based sector, the activities dealing with the forest resource component were focussed on a better understanding and characterisation of the different functions and processes involved in the respective forest systems. The main objectives were to provide forest data and indicator values to ToSIA- analyses, and to assess the sustainability impacts of alternative future forest management systems.

Four bio-regions and nine reference forests.

To describe the European forests, eight main tree species or group of species were selected over four bio-geographical zones with the objective of covering approximately 80% of the current wood flow in Europe and to reflect the existing variability of forest productivity and management regimes in Europe.

Bioregions and main tree species

Boreal	Central	Atlantic	Mediterranean
Norway spruce Scots pine Birch	Beech Norway spruce Scots pine Oak	Sitka spruce Maitime pine Eucalyptus	Eucalyptus Mixed conifers

In contrast to the time horizon of 25 years normally applied in EFORWOOD, long term temporal horizons (2050) were considered for simulations of future forest resources under different types,

To assess the sustainability impacts of forest resource management, a framework of nine reference forests cases was defined, combining selected main tree species and forest types with regional characteristics and boundaries representative of European forests.

Forest management alternatives

In order to investigate the sustainability impacts of different forest management strategies in ToSIA, five alternatives along a gradient of management intensity, i.e. the intensity of intervention into natural processes, was described:

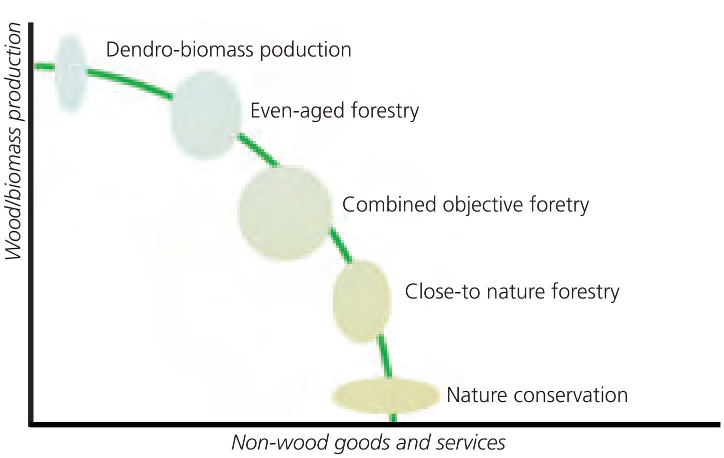
- **Unmanaged forest nature reserve**. Where the overall objective is to create natural ecological habitats and biodiversity. Only natural processes and disturbance regimes are allowed.
- **Close-to-nature forestry**. Where the objective is to emulate natural processes, but economic outturn is also important within this frame.
- **Combined objective forestry.** Where economical and ecological concerns play a major role. Objectives additional to typical timber production can be water protection, mushroom production, habitat production, avalanche protection, game management, fire protection or recreation.
- **Intensive even-aged forestry**. Where the main objective is to produce wood and profit. Ecological concerns are of less importance.
- **Wood biomass production**. Where the objective is to maximize the production of merchantable timber and/or wood biomass.

Stand level forest simulators were used to predict the development of the stands, growth rates and volume production as well as cash flows. The effect focussed on two main economic target variables, (1) merchantable wood volume produced, and (2) land expectation value at perpetuity.

The simulations showed large variations between the various forest management alternatives, both in the productivity ranking and in land expectation values. Those variations are related respectively to the growth dynamics of tree species, to preferences for specific assortments as expressed in stumpage prices, and to time as expressed through interest rates.

Reference forest	Bioregion	Tree species
1.Västerbotten, Sweden	Boreal	Norway spruce, Scots pine, birch
2.Baden-Würtenberg Germany	Central	Beech, Norway spruce
3.Silesia, Poland	Central	Scots pine
4.Lorraine, France	Central	Oak
5.Alpine region, Austria	Central	Norway spruce
6.Scotland, UK	Atlantic	Sitka spruce
7.Aquitaine, Frances	Atlantic	Maritime pine
8.Portugal	Atlantic	Eucalyptus, Maritime pine
9.Catalonia, Spain	Mediterinean	Mixed conifers

Forest management alternatives



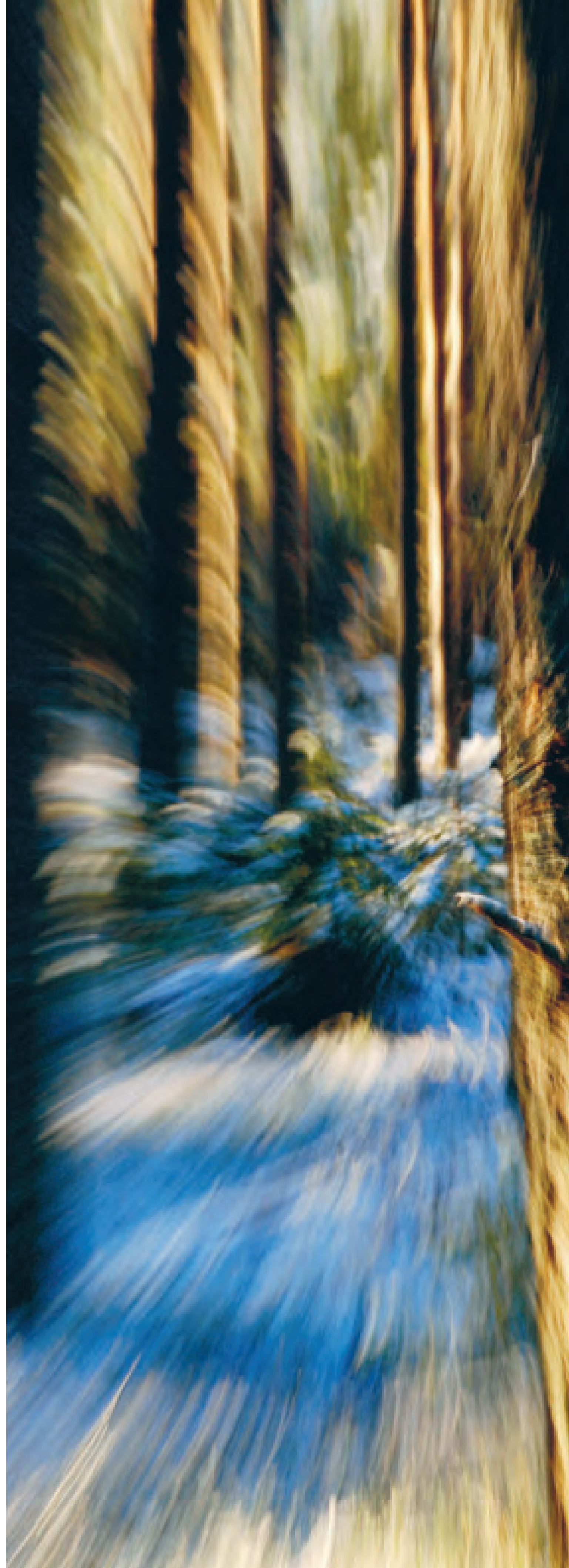


PHOTO: ERIK VIKLUND/SKOGENBILD

Simulation models

In order to generate reliable indicator data for the EFORWOOD case studies, models were used to simulate the forest development based on specified assumptions. In some cases existing ones were used, in other cases they were specifically developed or improved.

- Regional forest resource simulators were used for simulating data for ToSIA applications in 2015 and 2025 for the case studies. Research included improvement of the models and integration into regional simulators to predict the future development of the forests in a given region.
- The European forest simulator EFISCEN was restructured and new models developed for this purpose and used for providing forest resource data and other indicator values for ToSIA.

The new simulator EFISCEN-SPACE is of high spatial resolution (1 km x 1 km) and allows analysis of the development of forest resources on a regional to European scale under scenarios of management, societal demand and environmental circumstances.

The model is based on a large set of data for National Forest Inventory plot levels integrated into a GIS framework, including earlier pan-European forest maps and related information. The model works with 20 tree species groups over an extent covering the EU, extended with Norway, Switzerland, the Balkans, Moldavia, Belarus and Ukraine . The use of a GIS framework allows incorporation of spatial information (soil maps, elevation, NATURA 2000 sites, ...) in the model. The model simulates forest dynamics in terms of forest area, species composition, stand structure, standing volume, current annual increment, as well as harvested volumes of timber by thinning and final felling at the km2.

Environmental services

A comprehensive review of the impacts of silvicultural operations on environmental services was conducted and responses described for different forest management alternatives (FMAs). Further, a specific regional analysis was developed to illustrate synergies and trade-offs by quantifying the impact of five FMAs on selected production, as well as on environmental services, i.e. merchantable timber production, land expectation value, biodiversity, water quality, water quantity, soil fertility, carbon sequestration and carbon stock.

The specific impact analysis is based on simulation of a virtual reference normal forest located in a central European sub-mountain vegetation zone, with Norway spruce and European beech being the dominant tree species. The quantification of impacts further allows a balancing of the supply of forest functions through selecting appropriate management intensity being subject to multi-objective forest planning. Results illustrate that maximizing biomass production and carbon sequestration rates may be contradictory to maintaining protection of biodiversity. Several operations may, however, have positive effects on biodiversity and water protection without high costs. Water quality and quantity, and maintenance of future soil fertility may be affected either positively or negatively by several forest management operations; water quantity can be influenced by forest management only within a narrow range.

Social and cultural values

Research was carried out to derive scores for the recreational value of 240 forest stand types across Europe. The scores were obtained through a Delphi survey involving 46 European experts organised into 4 regional panels: United Kingdom, Nordic Region, Central Europe, and Iberia. In each region, 60 forest stand types were defined according to 3 tree species types (conifer, broadleaved, and mixed), 4 phases of development, and 5 forest management alternatives on a continuum from low to high levels of management intensity. The resulting scores were applied in two ways:

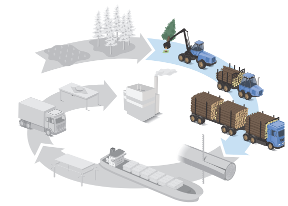
- First, conjoint analysis was used to determine, in each European region, the relative importance of the three variables that defined the forest stand types: type of tree species, phase of development (i.e. stand age), and forest management alternative. Across the four European regions, management alternative and stand age explained most of the variation in recreational scores, and were of roughly equal importance. Tree species was of relatively minor significance; its importance was around one third of that of the other two variables.
- The second way in which the scores were applied was to combine them with outputs from the European forest resource projection model, EFISCEN, to estimate current and future recreational values under different scenarios of nature conservation implementation (c.f. EU case study scenarios). The results suggest that overall an increase in forest area managed for conservation would cause a slight net increase in the recreational value per hectare of forests in Europe, although there is considerable variation between countries.

PHOTO: BJÖRN SVENSSON/SKOGENBILD

Risk assessment

The method to perform Multi-Criteria Risk Analysis was developed and applied to the reference forests in Europe to rank management alternatives according to their potential effect on forest health at the stand level. Overall, risk was lower in intensively managed short rotation forests designed to produce wood biomass, because of the reduced susceptibility of stands to the most damaging hazards. At the opposite end of the management intensity gradient, close- to-nature systems also had low overall risk, this time due to lower stand exposure to damage. Intensive even-aged forestry appeared to be subject to the greatest risk, irrespective of tree species and bioclimatic zone.

Contact person
JEAN-MICHEL CARNUS
INRA - Centre Bordeaux Aquitaine,
France
carnus@pierroton.inra.fr



FOREST TO INDUSTRY INTERACTIONS

MODULE 3

Introduction

The objective of this module was to identify processes and products in the part of the wood chain linking the forest to the wood processing industry, and to provide ToSIA with data on these processes and products. This module covers all activities related to the conversion of living trees into pre-processed materials fed into industrial processes.

Data about raw material allocation, harvesting and transport were collected, analysed and aggregated. Key indicators and future developments were identified and partial models developed to assess a range of sustainability indicators. This task included the allocation of appropriate raw materials to specific products and production processes, with impacts on material efficiency, process effectiveness, energy and chemical use and economy. Product lines, which play a major role in regional cases as well as in the European context, were analysed for wooden products and panels, fibre based products and bio-energy.

This included harvesting activities with respect to their possible negative impacts on landscape, recreation, watershed, or soil. Additionally, their beneficial impacts on economy, considering also increased levels of mechanisation were analysed. Current and future transport activities, which have major impacts on sustainability levels, were also analysed. Different transport modes (road, rail, water), mixed systems, advanced logistics and distribution systems were taken into account.

Specified activities

The work was divided into four research workpackages.

1. Harvesting systems analysed the impacts of selected product lines. Environmental and economical, as well as social aspects were analysed and quantified for case studies in which relevant harvesting systems (e.g. motor-manual and fully mechanized) for the harvest of roundwood, and systems for harvesting of forest fuel (bio-energy) were represented. The interaction between forest management practice and harvesting and hauling operations (logging) and the effects on sustainability levels were assessed. Weak spots from economical and environmental points of view were identified. The products from the logging operations were allocated to the next relevant industrial application.

2. Transport systems evaluated alternative transport systems and logistical options for their impacts on sustainability. Transport is one of the most impact-relevant activities in forest wood chains, with significant effects on costs, energy use and emission of greenhouse gases. It is dependent on infrastructure, traffic and the industry's demand on wood properties. However, transport systems also provide job and income opportunities, especially in rural areas and for small enterprises. Efficient allocation of wood raw material relies on effective transport solutions. Harvesting and transport systems have intensive interactions. Existing and future solutions for all types of transport were analysed for their impact on sustainability . This included road, rail, and inland- and maritime water,as well as integrated concepts as well as storage issues between the forest and the industry.

More detailed information on transport aspects can be found in the appendix "Transport within the forest-wood chain". game management, fire protection or recreation.

PHOTO: CORBIS/MATTON IMAGES

3. Quality assessment and allocation studied the consequences of raw material allocation on sustainability. In the production of wood based products, wood is normally the most important input factor in terms of volume and value. The properties of wood and fibres, as well as their variations have a strong influence on production processes and the quality of wood-based products.

Furthermore, natural variability between and within tree species, and in growth conditions and different management systems in the forest, can result in highly variable properties of the forest resource. Whilst this variability offers opportunities to select suitable wood raw materials for specific products, it may also cause disruption to processes, resulting in increased costs and quality problems, if not considered adeqautely.

The allocation of wood raw materials with uniform and appropriate properties is crucial for sustainability, bringing higher product yield, added value and customer satisfaction. It often means lower costs, reduced waste, less rejects, smaller input of energy, chemicals and manpower and less transport, all of which have an impact on sustainability. A set of product types has been defined and their demands on the wood and fibre properties of the raw materials used have been outlined.

Models for the prediction of properties have been utilised in simulations to map volumes and properties of forest resources, which have been illustrated in the four case studies addressing different aspects of the wood chain. Sustainability effects of wood allocation along product chains have been illustrated with two special analyses: one addressing solid wood products and bio- energy, and one for a fibre-based product, including operations from the forest to the recycled end product. These two cases are described in greater detail in the following pages.

4. Integrated partial chain modelling applied the results from the work of the other work- packages and the related models, and integrated them into an holistic view of the partial chain between forest and industry. The existing situation and its variations throughout Europe were included in this analysis. The link to sections on forest resource and management and on industry processing and manufacturing were established by network analysis. These links between definitions and measurement concepts for sustainability impacts along partial chains were defined with input- output models. Specific objectives were the establishment of a set of module-specific common indicators and criteria. The related assessment and measurement concepts were analysed. The analyses took into account environmental, economic and social indicators of typical reference chains. Existing and future allocation, harvesting and transport solutions for relevant timber, fiber and bio-energy products were taken into account.

Special analysis 1:

Location of Craik Forest showing transport routes for different products. Brown arrow = Biomass, Blue arrow = pallet logs, green arrow = best quality "green" sawlogs, red arrows = poorer quality "red" sawlogs. Dashed red arrow shows re-transported rejected sawlogs.

Solid wood products and bio energy, South Scotland

This study focused on Craik Forest, South Scotland, which is approximately 5000 ha in size. The purpose was to examine the current management plans and to make modifications to the allocation system, including altering how the timber is cut, which sawmill the material is sent to, and increasing the harvesting of material for biomass.

All stands designated for harvesting between 2005 and 2030 were included in the simulation. A product allocation model was used to compare different log breakout scenarios and predictions were made of the average stem form within the stand as well as the wood stiffness of the trees. Within the different scenarios, log product proportions were adjusted based on the log diameter, stem straightness and stiffness of the timber. The final result was a prediction of the volumes of logs that will become available for different uses (structural timber, pallet wood, and biomass) using different allocation strategies. The impacts of the alternative allocation scenarios were measured using four key indicators: Gross Value Added (GVA), total transport distance (miles), total greenhouse gas emission (kg CO_2), and total employment in person years.

Alternatives investigated were:

1. Business as usual. The current allocation method using log top diameter only leads to 20% of all sawlogs being rejected and re-transported for processing as "red" logs.

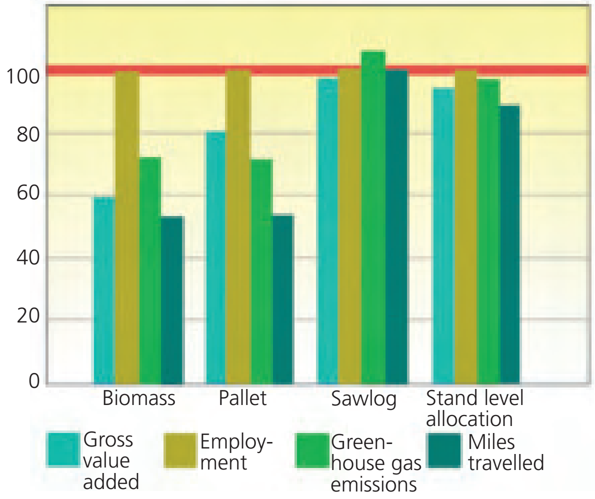
2. Forest level allocation. All the material to be harvested from the forest was allocated to one of three possible alternatives; Biomass (alternative 2a), Pallet (alternative 2b), or Sawlog (alternative 2c).

3. Stand level allocation. Based on the predicted stem and wood properties of the trees, all logs from each stand are allocated to a primary processor. The assumption was that this allocation should lead to no rejection and no re-transport of sawlogs (alternative 3).

Results

The absolute values for each sustainability indicator were calculated over the period 2005– 2030. For all the alternative scenarios the gross value added was reduced compared with business as usual. The greatest reduction was in the forest level allocation alternative, when all the material was treated as biomass (alternative 2a). However, greenhouse gas emissions and miles travelled were also reduced in most of the alternative scenarios. The impact on employment was much smaller with little difference between the scenarios.

Comment: The scenarios demonstrate that it is possible to calculate sustainability indicators of value and importance for the forest based industries for a range of allocation options if the background data are available.



Relative sustainability impact for the alternatives studied, red line is business as usual.
Biomass is alternative 2a; pallet is alternative 2b; sawlog is alternative 2c and stand level allocation is alternative 3.

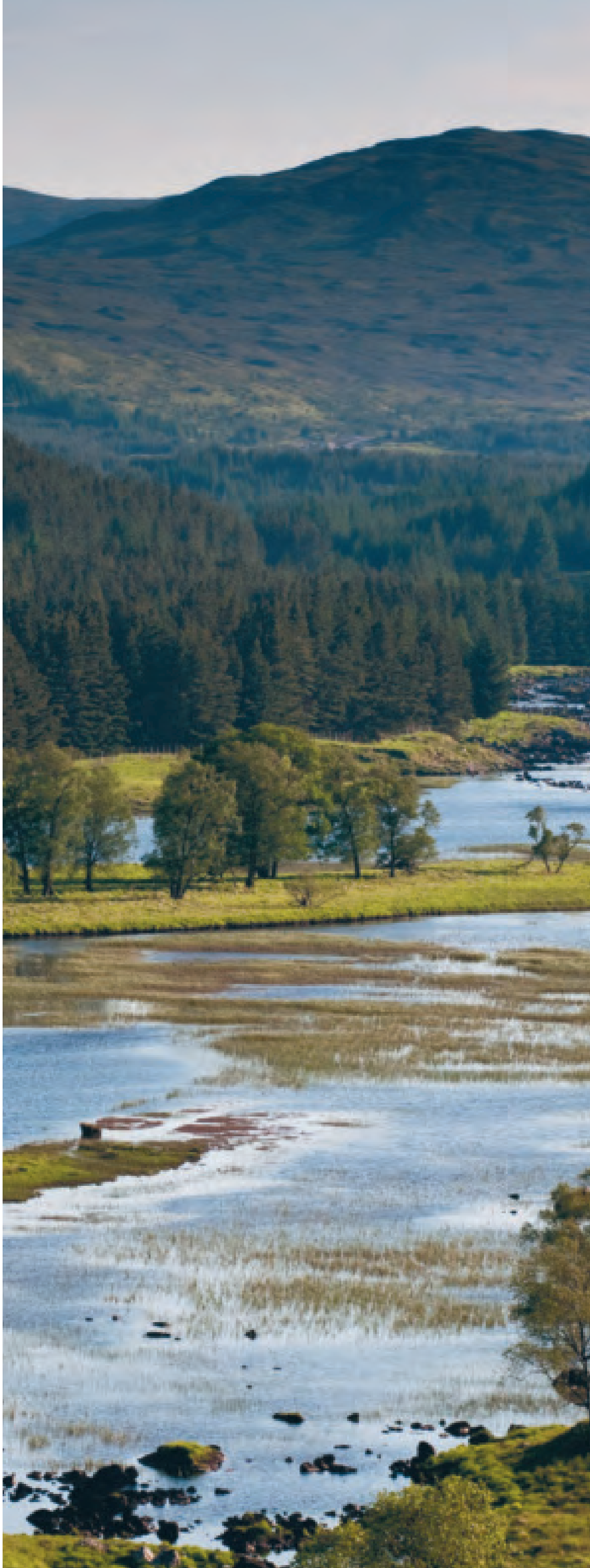


PHOTO: ISTOCK

Special analysis 2:

Kraftliner, corrugated boxes and recycling, Västerbotten – Germany

This analysis dealt with the production, use and recycling of boxes from corrugated materials, produced with flat layers of liner on the surfaces and a waved sheet in between, starting with fibres in the forest. The aim was to illustrate what can be achieved through better use of the available forest resource.

Assumptions and comments

Two alternatives in raw-material procurement were defined:

1. Wood is allocated to the mill as today, but the loads of logs arriving at the mill were classified according to their average properties. The operations in the woodyard were adapted to supply more uniform and suitable wood for each product.

2. The operations in the forest were the same as today, but the pulpwood from each stand was classified for use in a particular product. In addition, the forest area supplying the mill was increased by 30 % to allow selection of more suitable wood.

The more suitable wood will result in better kraft pulps, from which the mill may produce kraftliner with the same or better properties but lower cost. This provides opportunities for re- optimisation of processes along the whole chain. The options studies aim to produce kraftliner with the same properties, but:

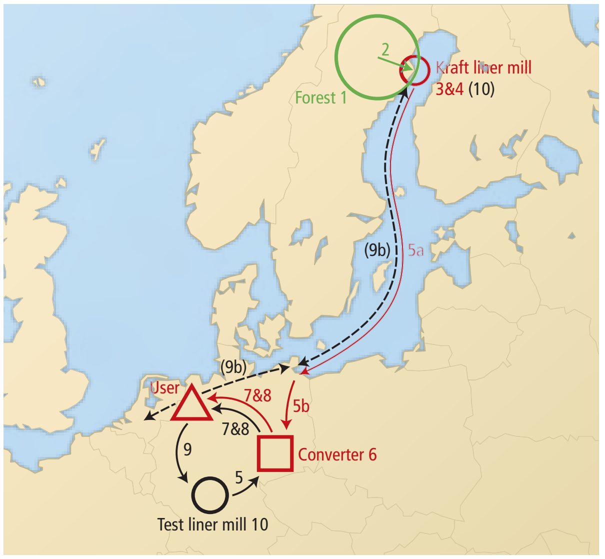
A. a lighter kraftliner, which was possible due to better kraft pulp produced from improved wood: 5 % material saving was assumed possible for allocation alternative 1 above and 10 % for alternative 2.

B. a kraftliner with the same weight, thickness and properties, but with some of the kraft pulp from the region replaced for with recycled fibre from boxes used in Germany and shipped to Sweden: 10 % recycled fibre for allocation alternative 1 and 20 % for alternative 2.

This defines four alternatives: A1, A2, B1 and B2, which were compared with the current situation as a reference. Only factors which change were included in the calculations, to reduce the complexity. The alternatives were compared on the basis of maintaining the same supply of boxes to the end users. To estimate the consequences of these assumptions in the pulp and paper mill, material and energy balances were calculated, using existing detailed mill models.

Results

Most indicators were strongly influenced by the kraft pulp needed per box. All alternatives involved decreased production of kraft pulp, which also results in the use of less wood from the forest, less transportation of wood but more transportation of recycled fibres in the B cases, etc. The production cost was even more influenced when the weight of the kraftliner was reduced.

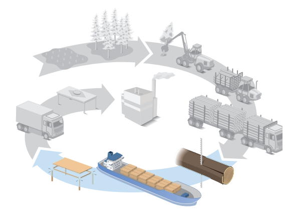


The product chain starts in the forest resource of Västerbotten (1). Wood was transported (2) to an integrated pulp and paper mill. Kraft pulp was produced (3) and from this kraftliner (4). The kraftliner was transported on ship (5a) and rail (5b) to a converting plant in Germany (6). Boxes are produced, distributed (7), used (8) and collected (9) for production of testliner (10) from recycled materials.
Four alternatives were studied. In two of the them, some recycled material was brought to Västerbotten and mixed with the fibres from the forest.

Indicator	A1	A2	B1	B2
Employment	-4.2%	-8.3%	-8.3%	-16.6%
Occupational accidents	-2.6%	-5.1%	-5.1%	-10.2%
Production cost/ton	-5.0%	-10.1%	-2.2%	-4.4%
Production cost/m2	-5.3%	-11.1%	-2.2%	-4.4%
CO2 from wood combustion	-4.4%	-8.7%	-5.7%	-11.3%
CO2 from fossil fuel	-8.4%	-9.8%	-5.6%	-11.3%

Relative sustainability impact for thefour alternatives studied compared with the current situation.

Contact person
GERO BECKER
Albert Ludwigs University
Germany
institut@fobawi.uni-freiburg.de



PROCESSING AND MANUFACTURING

MODULE 4

Introduction and policy perspective

The aim of Module 4 ("Processing and manufacturing") in EFORWOOD was to compile relevant sustainability criteria and indicators for forest based industry, collect data for the indicators and finally to study the sustainability impacts of the forest-based industrial processes. An overview of major EU policies and legislations impacting upon the European FWC was developed in order to identify the main industrial interests in the context of EFORWOOD. The report addresses the impacts from both current and future EU policies, such as "thematic strategies" sending political messages and paving the way for potential upcoming regulatory acts, and to legislative rules in force or proposed. In addition, the report stresses the relevant standardisation issues as well as their respective consequences on the forestry-wood chain and the major policies driven by the industrial sectors themselves. The results from EFORWOOD have created the possibility of providing answers for the most relevant sustainability questions of the industry.

Dynamics of the industry

The main industry sectors analyzed are pulp and paper industry, solid wood industry, wood products industry and wood based bio-energy sector. These industries were chosen to represent the forest-based industries collectively. The selected industry sectors represent a constantly changing and highly complex system with several connections and feedback loops between different actors. One of the promising future forest related concepts, bio- refinery, represents an entirely new and dynamic aspect for the industry. Bio-refinery, which was not included as a topic in this work, can be regarded as an even more complex and rapidly evolving part of the forest based industry.

In the solid wood industry, hardwood sawnwood is with a few exceptions, manufactured by small, local companies, particularly located in South-East Asia, Africa, South and North America. Softwood sawnwood is produced in larger industrial businesses, normally with regional or even global operations. The wastes of from the solid wood industry constitute a material flow input to other industries. In the wood products industry, panels are typically home market products and not traded within long distances. Today, paper mills too are often located close to consumers. Technical developments have made possible a high percentage of recycled pulp for almost all paper grades, a location close to consumers also often means close to the raw material. On the other hand, especially in the pulp market ,some products (e.g. papergrades) are produced at one place and consumed at another. The importance of wood based bio-energy is continuously growing and it will have an Increasingly significant effect both on forest industry dynamics and sustainability.

All of the described industries are linked together through material flows and there are several feedback loops within the industry. The various actors in the industry have always had a strong economic connection. If one of the actors in the chain fails to be economically feasible, other players in the chain suffer. Today the same effect can be seen in environmental and social issues as well. If one player of the chain fails to take specific environmental issues into consideration, the whole chain suffers.

The overall picture of the forest industry's competitiveness and the industry dynamics has to be kept in mind in the interpretation of ToSIA results and the EFORWOOD work in general. The competitive balance between the forest industry actors is highly dynamic. Power shifts in competition can be sudden, e.g. based on exchange rate fluctuations, unfair regulatory environments, the shifts in resource focus, cost

and availability and industry restructuring.

From the industry dynamics point of view, modelling the feedback loops of some indicators and value chains in ToSIA has turned out to be problematic. At least until now, ToSIA should not be used as the only tool in estimating changes in the dynamics and production capacities within the industry, e.g. assessing where new production capacity will be built or where capacity will be closed.

Bio-energy

Bio-energy, together with the pulp and paper and solid wood value chains, represent the three main value chains of the forest industry. Today the main user of forest bio-energy is the forest industry itself. A simplified approach to study these flows was chosen. The only bio-energy product studied by process modeling was pellets.

Major part of the forest biomass finally ends up as energy. Almost half of the material stream is converted to energy and used within the industrial processes and a major part of the rest of the biomass (in products) ends up as energy through energy production (pellets), waste combustion or landfill gas utilization (from waste disposal).

To be able to handle the bio-energy value chain in an equal way as the two other value chains, a huge number of new processes would have been needed in the EFORWOOD modelling. This approach would have been complex, especially data collection, as the flows and indicators are already integrated in bigger process concepts and the specific industrial data are not generally available. Furthermore, the indicator values of the integrated industrial processes would also have been affected and data collection from these made more complex.

One important finding is that, based on the present forest biomass flow to the industry, more energy can in principle only be produced by increasing energy conversion rates of present biomass-to-energy processes, or by allocating a bigger proportion of the biomass flow to bio-energy processes. The first option would not affect the material flow into pulp and paper or sawn-wood products, but the second would. On the other hand, biomass resources such as forest residue and stumps are still available from the present forest growth and may of course be introduced as new flows. A future option to produce more forest biomass for energy purposes is also to grow more biomass on the same forest area but this option will probably also affect the amount and the quality of raw material available for pulp and paper and/or sawn- wood.

Future studies might be focused on eg. how to improve the quality (electricity instead of heat) and the monetary value of the energy produced out of forest biomass. To make such studies using the ToSIA approach, the bigger process concepts must be split into sub-processes on such a level that forest industry internal biomass-to-energy conversion can be studied, but this would also allow studies of completely new, forest industry integrated processes such as liquid bio-fuel production.

The challenging EU climate change and renewable energy related strategies until 2020 and 2050 will probably increase the energy efficiency of processes and also affect the material flows within the forest industry. In the future, ToSIA could be used to support decisions on the most sustainable options for future EU strategies. However, this was not a research question of EFORWOOD and this issue will need to be considered for future studies.

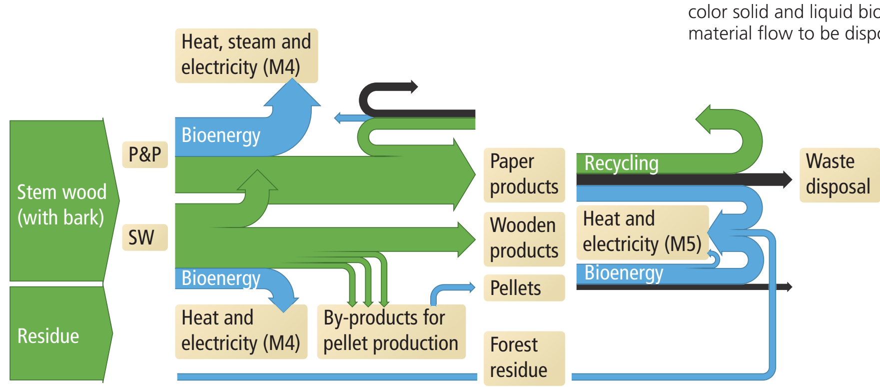


Fig 1. Principle picture of bio-energy and material flows studied in EFORWOOD. Green color indicates material flows, blue color solid and liquid bio-fuels and black color material flow to be disposed.

PHOTO: BO GÖRAN BACKSTRÖM/SKOGENBILD

A kraft pulp mill is also a big energy producer. SCA's kraft pulp mill Östrand in northern Sweden has a soda recovery boiler which produces steam with higher pressure and temperature than any other soda boiler in the world. This allows Östrand to produce 0.5 TWh of green electricity in a turbine, far more than the consumption of the kraft mill. Photo: SCA

EFORWOOD SUSTAINABILITY INDICATORS IN THE LIGHT OF INDUSTRY

The EFORWOOD indicator set aims at consistency with other sustainability indicator frameworks in Europe and globally. After an extensive selection procedure, a list of sustainability indicators for the Forest-wood chain was compiled. Not least from an industry perspective, the social indicators are the most uncertain and most difficult to analyse and interpret compared to the economic and environmental indicators.

Social indicators

The choice of a certain indicator to represent the social indicator is not always undisputed. The, to some extent, arbitrary nature of the distinction between the three fields of sustainability can present problems. Employment, for example, could be considered as both the social as well as the economic field. Corporate social responsibility obviously refers to the company, whereas health and safety refers to the employee. This is certainly the case with labour costs versus wages and salaries. Here, not only does the focus change from company to employee, but the direction of preference also changes. Moreover, social indicators are often qualitative in nature, which makes data collection difficult. Also the inclusion of qualitative social indicators in an analysis, together with the often quantitative economic and environmental indicators, can be problematic. This creates a risk concerning the selection of a social indicator based on its ability to be expressed quantitatively, rather than selecting an indicator that represents quality of life and/or human wellbeing most accurately.

Although the ToSIA results do not express a preferred direction of change or threshold value, a difficulty with social indicators is that the direction of preference is not always unambiguous. As opposed to environmental indicators for example, where it is clear that high toxic emissions are worse than low emission levels or low energy use is better than high, some social indicators are more difficult to prioritise. One of the social indicators is the number of people working part-time. Many persons will judge having a full-time contract as positive. However, it could be the case that half the employees would actually prefer to work part-time. In this case the indicator measures a social aspect, so, the value assigned to the measurement can change according to personal preference.

Environmental indicators

Ten environmental indicators were chosen in EFORWOOD, six of which were directly focused on industrial processes and linked to energy, water and solid waste. Although carbon footprint is important and a widely used 'indicator' at the moment, it is not included in the EFORWOOD analyses, and nor is the carbon content of a product. Indicators that measure inherent energy generation from wood raw materials are important indicators for the forest industry, which produces renewable energy inherently within the process as well as for external use. Energy use is its own indicator and it takes into account how much renewable energy (bark, wood residuals) has been used. Direct greenhouse gas emissions as CO_2 equivalent are expressed as an indicator of its own.

The use of water, emissions to water and production of solid waste are of industrial interest. Indicators that describe the quality of waste water are BOD (biochemical oxygen demand) and nutrients such as nitrogen and phosphorous. Air emissions other than GHG emissions are CO_2, NOx, SO_2 and volatile organic compounds (NMVOC). The total amount of waste is an indicator, specified with non-hazardous and hazardous waste.

Economic indicators

Among economic indicators of importance to the forest industry, gross value added is particularly relevant. The challenge is to change these indicator values representing company level to represent only few products described in the forest wood chain. (meaning of this last sentence not clear). It was found that very important indicators such as Investments, R&D expenditures and Innovations are seldom clearly reported. Innovation describing the economic sustainability of the industry is crucial. However, as innovation can be a special technical innovation in a single product or a general innovation providing advances for a whole industry sector, it proves difficult to value the effects of different innovations in terms of any single product. Overall the work done in compiling the indicator lists, in defining the indicators and compiling the information and data linked to the indicators, has generated valuable information not only on data availability and gaps but also on future development needs

Contact person
HELENA WESSMAN
VTT, Technical Research
Centre of Finland, Finland.
helena.wessman@vtt.fi

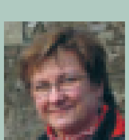
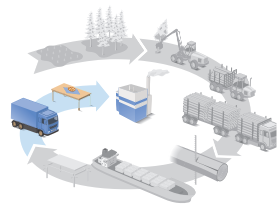


PHOTO: SCA



INDUSTRY TO CONSUMER INTERACTIONS

MODULE 5

A market-oriented approach is crucial when sustainability in the forest-wood chain is assessed. Consumers, professional users and businesses buy and use products with full or partial material origin in the forest. Commodity type products (e.g. paper rolls, pellets, board and sawn wood) are used in other interacting value chains (e.g. food, media, energy, house construction) for further processing and value adding. Forest-based materials, components and products are incorporated into different products of different complexities consisting of various materials.

A key aspect for sustainability in the forest-wood chain is to understand the perception of and suggest improvements in forest-based materials and products, so that they have a positive impact on overall functional performance and sustainability in interacting final-product value chains. This includes also considerations of material recycling and energy recovery, where used products are transferred back to the industry through reverse logistics, where they can be re-utilised as material input to the manufacture of new products or to generate energy.

There has been a strong focus in the project on quantitative data collection for the ToSIA runs. In particular the module on "Industry to consumer interactions" has spent more resources on quantitative data collection than originally anticipated. Nevertheless, the interacting value chains have primarily been dealt with using a qualitative approach in methodologies and data, including interaction with stakeholders downstream the value chain. The availability of and access to quantitative data for interacting chains is very limited, and the indicator values that can be obtained often relate more to other materials (e.g. steel, plastics, concrete) than to the wood-based materials relevant to the forest industries. It is therefore also extremely difficult to try to evaluate the indicator values for the downstream parts of the chain. The number of end-products and markets for FWC-based materials is very large and hence a high level of aggregation must be applied in the evaluation to keep the number of products and processes at a manageable level.

Aggregation, on the one hand simplifies the analysis of results, but it can also make the analysis more difficult, for example when cause-effect correlations are evaluated. Using the printing sector as an example, different printing techniques are used in offset, flexo and gravure so the sustainability performance and profile for these technologies will be quite different. However, in the EFORWOOD project sustainability data was collected for the printing sector as a whole so as to limit the number of processes in the system topology. This means that estimates had to be made of the proportions for the different respective technologies used, and then weighted averages for the sustainability indicators calculated for the sector as a whole. At the same time the impact of non-wood based materials on these indicators had to be excluded.

These foreign materials can relate to printing inks and plastics substrates for example. Having excluded non- wood materials it was often still necessary to disaggregate the results in order to carry out a meaningful interpretation of the ToSIA results. This disaggregation is however not supported by ToSIA, and this makes the interpretation of results very difficult and time consuming. Difficulties with disaggregation were also experienced in the market-driven case studies in the project (e.g. Iberia). Official statistics do not support the disaggregation of certain components, for example in a chair, and the tracing of them back to their origin in the forest-wood chain.

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An innumerable number
of consumer products originates from
tree biomass, wood and wood fibre.

PHOTO: BIGSTOCK

Results / Data collection

One of the challenges was to find indicator data for such a very heterogeneous industry consisting of a large number of products and actors. In some cases limited data availability was a difficulty for specific indicators and regions of Europe. In other cases, though information was generally available it was at a different aggregation level than the one that was needed for this project. This resulted in a reduction in the data quality. The data collection process in the project has provided very useful information about the gaps in availability and development needs of the different databases. As the amount of data collected by partners is substantial, good definition of it is required and assumptions behind the data collection are crucial.

The data collection for the reference futures and scenarios were based on different models such as EFI-GTM. While analyzing the results of ToSIA, it has to be taken into account that the data in reference futures and scenarios are estimates. This is especially important when the economic environment is so turbulent that creating future predictions is even more challenging.

Results / Consumer attitudes

Research carried out on consumer attitudes, had the aim of investigating the perceptions and attitudes of consumers and business customers related to different wood-based products. Qualitative methods were used based on input from experts, professional buyers and end-users. The products investigated included those from the solid wood sector (furniture), the energy/ bio- energy sector (pellets), the fibre-based packaging sector (juice packaging) and the fibre based printed material industry (books).

The results of the research into consumer perceptions are qualitative, and the identified hot spots indicate strengths and weaknesses in the consumption of the wood-based products with regard to sustainability. The hot spots are the key aspects influencing consumer behaviour during the purchasing process and are of different levels of importance. Hot spots indicate areas of action and, in some cases, the need for further studies where knowledge gaps exist in relation to consumption.

There are strong links between the three pillars of sustainability and consumer behaviour. According to the conclusions concerning sustainability, there are two main profiles of consumers in Europe namely the environmentally conscious and the environmentally non- conscious consumers. In professional markets

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(business to business) the main profile is the non-conscious one, although companies may try to show an environmentally sound image to their markets.

It can be stated that in Europe there is an essential need for better informing of consumers on the topic of sustainability. This is true not only when referring to environmental issues, but also in the economic and social dimensions, and especially in relation to the consequences of their buying habits throughout the entire value chain. This issue of sector credibility is very important in a sustainability context. Some consumers find sustainability arguments to be spurious, so they are sceptical about them often considering sustainability as an issue of fashion or political correctness. Hence, informing people and making them aware of sustainability matters when buying and consuming (wood-based) products, is important. This task is huge, and action will be needed also on societal level.

Sector SWOT-analysis

SWOT analysis relates to evaluation of Strengths, Weaknesses, Opportunities, and Threats. The purpose of SWOT analysis in this project was to identify the key internal factors (under Strengths and Weaknesses) and external factors (under Opportunities and Threats) that are important to achieve sustainable supply and demand for products from the European forest-wood chains as represented by solid-wood products, packaging, printed matters and bio-energy. The methodology applied in the analysis was as follows:

a) With usage of “Hot spot”-methodology strenghts and weaknesses were determined and described for each sub-sector in the forest-wood chain.

b) With simplified Morphological Analysis methodology, significant components of future scenarios (2020) was identified. Two extreme scenarios have been created with usage of those components, one positive/optimistic and one negative/pessimistic. All components of each scenario have been reviewed as opportunities or threats with respect to sector sustainability.

c) Three significant questions directly linked to sector sustainability have been elaborated and discussed with stakeholders to support drafting of strategies:

1. How to make business-customers and consumers interested in the environmental advantages of forest products.

2. How to strengthen the environmental credibility of the European forest-based industries.

3. How to maintain or increase competitiveness for the forest-wood chain sub- sectors on the market?

Pro-active strategies

SWOT analyses are fundamental for the development of pro-active strategies. An example is given below concerning the question of how to maintain or increase competitiveness of the printing and publishing sector.

Only one weakness, and very few threats were identified, so the strategies were developed with the primary aim of using strengths in order to exploit opportunities. The following *Product and Distribution Strategies* were drafted as a result of the analyses.

Product strategies for the sector could concentrate on improving product differentiation, implementing innovations in products and in their features, as well as creating a price/ product quality structure that satisfies individual customer preferences. A combination of cost and differentiation advantages seems possible as customers and end-consumers expressed price sensitivity related to quality. For example:

- The sector can offer some printed and published products at a lower price, since lower quality is accepted in some customer segments.
- Delivering individualized products that carry benefits that exceed those of competing products is a potential growth segment.

The *Distribution Strategy* is based on a holistic view and close collaboration in the value chain. Some examples of proposed actions in this context are:

- Apply predictive and statistical modeling more frequently in order to improve responsiveness and dynamics.
- Increase cross-sector collaboration with governments, local authorities, customers, suppliers and other stakeholders aiming at more holistic solutions with joint benefits.
- Further develop and exploit relationships with transport companies, wholesalers and retailers, aiming at new business models and distribution channels.
- Modify and develop new models of distribution to deliver highly customized and individualistic products.
- Lean distribution to reduce environmental impact and cut costs.

Conclusions and further work

The research has confirmed that market-oriented aspects are crucial in sustainability assessment of the forest-wood chain. To address these aspects, both quantitative and qualitative methods have been applied in combination. The quantitative part mainly relates to ToSIA. The difficulties and resource input needed to accomplish this part were underestimated in the project. Problems have arisen in areas such as:

- The wide range of products where wood-based materials are used.
- Isolating the impact for products made of multiple materials including non-wood based materials (e.g. furniture, packaged goods).
- The limited availability of official statistics, especially in the SME dominated wood sector. This has meant that resource-intense expert “guesstimates” have had to be used frequently. Resources have also been used to develop tools to support “guesstimations”.
- Tracing the wood and fibres used in the final product applications to their origins in the forest. This was the reason why wood products were removed from the Iberia case study.
- The complexity and vast number of processes, even with a high aggregation level at the industry to consumer level.

Further work is recommended in two main areas:

1. Research involving the running and operation of ToSIA with different external scenarios to further validate the model itself, data input values and the results.

2. Stakeholder communication and dialogue to discuss:

- ToSIA results and their applicability and usefulness, as well as their potential implications for the FWC.
- The proposed pro-active industrial sustainability strategies and their potential upstream implications.

Contact person
CARL OLSMATS
Innventia AB
Sweden
carl.olsmats@innventia.com

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MANAGING A MULTINATIONAL PROGRAM

In the 6th Framework Program the European Commission launched a new instrument for funding research, called Integrated Projects. Among the ideas behind this new instrument were to support the European Research Area by increasing collaboration and integration among European research organisations and to better include co-operation with industry.

The launching of Integrated Projects was timely and well suited to fulfil the original ideas behind EFORWOOD. These ideas included integration of researchers from all parts of the Forest-based sector, by identifying a common, cross disciplinary research objective aimed at elaborating a decision support tool for public as well as private decision makers in the forest-based sector, to support decisions on a sustainable development.

To achieve the objectives of EFORWOOD, a large number of partners were necessary representing the geographical area of Europe, as well as all parts of the forestry-wood chain,. In total EFORWOOD engaged 38 partners from 21 countries, including some even from outside Europe. The total budget was around €20 mio for four years. Altogether more than 120 scientists have been engaged.

The fact that most partners did not have previous experience of collaboration amongst one another, meant that special efforts had to be put into finding a working scheme which facilitated collaboration aiming to solve the common goals of the project. On the one hand collaboration needed to take place among partners with similar competence but from different geographical areas, on the other, researchers with different scientific competencies from the same or different geographical areas were required to establish cross disciplinary working co-operations. In such a large project it was also important to minimise the risk of clustering among scientist, leading to different interpretations of the common goals or research, less focussed on the common objectives. There was also a risk of individual scientists being unable to have an overview of the overall development of the project.

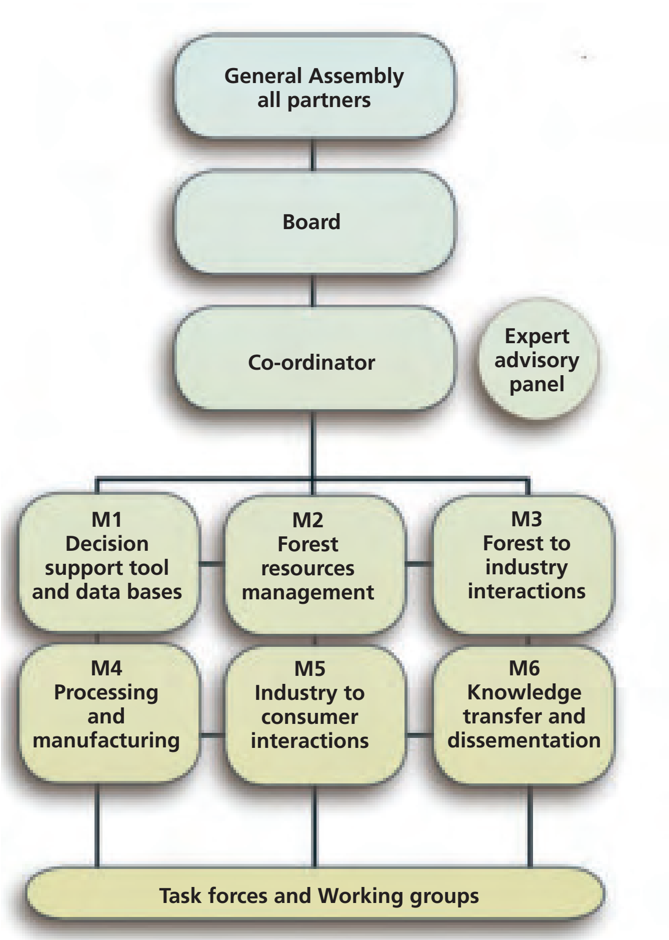
The project managing structure was designed to meet not only the challenges described above, but also two partly contradictory demands of EFORWOOD. On the one hand the need to map the European forest-based sector in all its parts along the value chain, and on the other to solve common, cross disciplinary problems that were expected to arise during the development of the project. The first demand was met by structuring the project in four modules (M2-M5) representing the logical parts of the value chains. These four modules were complemented by the synthesising module (M1), responsible for building the decision support tool and its complementary parts, and for compiling all data and other types of information from the four value chain modules. One module (M6) was given the responsibility of knowledge transfer and dissemination of project results and one (M0) for scientific and administrative management.

However, this structure in itself was not suitable for solving cross module problems which might arise. To handle these issues 'ad hoc', cross module Task Forces and Working Groups were formed whenever needed, each with an identified problem to solve within a specified time frame.

In order to meet the various challenges and to facilitate integration within the project, responsibilities were distributed among the partners as much as possible. Consequently, a significant number of partners were either responsible for a module, a work package within a module, or were given the responsibility of coordinating a Task Force or Working Group.

To ensure the formalised structure of the project worked as intended, partners had to be given opportunities to meet in person. The major facility to support personal contacts among project partners was the so-called EFORWOOD weeks. Dates for all nine EFORWOOD weeks were identified at the beginning of the project. All partners took part in these events, which were held twice a year. The EFORWOOD weeks proved to be very useful for both the scientific development of the project, as well as for networking of partners. Cultural and social values were recognised as being very important for a project of this scope and magnitude. Voluntary Partners took responsibility for organising the respective EFORWOOD weeks.

An important part of the project was to get the opinions of the many different stakeholders of the forest-based sector. Besides written communication, the major activity was the “road-shows”. A road-show event was characterised as a face to face meeting with a small shomogeneous group of people, often representing a single organisation, with the objective of getting stakeholder views and ensuring their input to specific developments within the project.



Conclusions

The management arrangements for the project proved, in the main, to be entirely appropriate and successful. Very good integration among the large number of partners was achieved. One particular experience was that a prerequisite for a successful management and integration in such a large, cross-disciplinary project as EFORWOOD, is a strong and committed team of core partners.

The proof of success is the fact that most of the initial project objectives were met and in particular that, probably for the first time, a cohesive network of scientists has been established in Europe representing the multi-disciplinary operations across the complete forest-based sector. The basis for a continuity of this network is discussed in the next section.

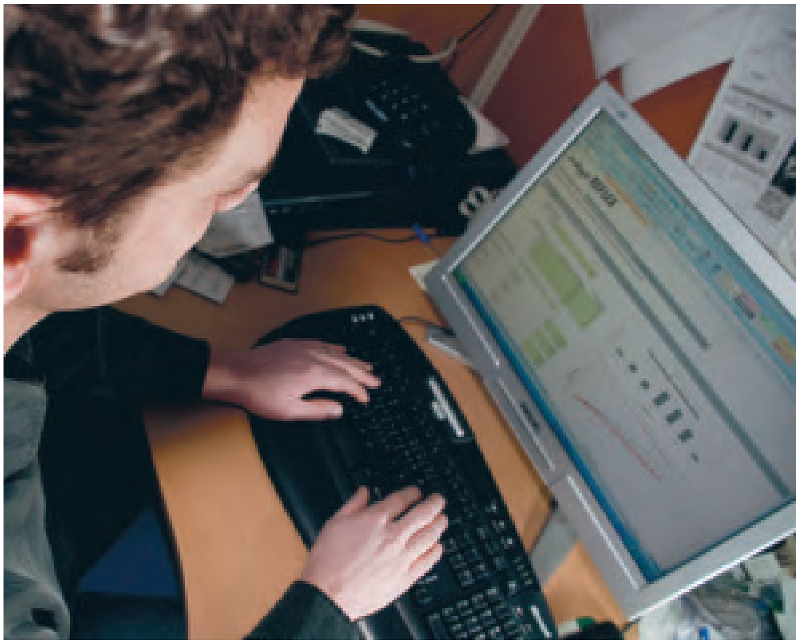
Coordinator
KAJ ROSÉN
The Forestry Research Insitute of Sweden.
kaj.rosen@skogforsk.se

POST PROJECT MANAGEMENT

The ambition of EFORWOOD to create a computer-based tool (ToSIA) to guide the forest-based sector towards increased sustainability has been achieved from a scientific point of view. ToSIA is designed for use by public as well as private decision makers related to the forest-based sector.

The original concept on which the EFORWOOD project was founded has proved realistic. ToSIA calculates sustainability impact quantitatively. The ambition to make ToSIA transparent has been achieved in that all assumptions concerning the different sustainability indicators made by the user of the tool can be identified and explored.

The scientific achievements of the EFORWOOD consortium will certainly be further developed in future follow-up projects. However, judgements on the success of this research project will be measured in the future by the willingness of stakeholders to accept and use ToSIA. To facilitate further the scientific development and use of the tool, the partners of the EFORWOOD consortium have decided to establish a standing network entitled “ToSIA Management and User Group” (TMUG) which is open to all EFORWOOD partner organisations as well as to other interested research and user organisations. Membership of the TMUG requires the acceptance of the Memorandum of Understanding which defines the activities to be conducted by the members of the TMUG. The TMUG will be managed by the European Forest Institute (EFI).



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Contact person
KAJ ROSÉN
The Forestry Research Insitute of Sweden.
kaj.rosen@skogforsk.se

READ MORE

Helming K, Perez-Soba M, Tabbush P (eds) 2008: Sustainability impact assessment of land use changes. Berlin, Springer.

Huijbregts, M.A.J., Hellweg, S., Frischknecht, R., Hungerbühler, K., Hendriks, A.J., 2008. Ecological footprint accounting in the life cycle assessment of products. Ecological Economics 64, 798-807.

http://trade.ec.europa.eu/doclib/html/125566. htm

Katila, M., Simula, M., 2005. Sustainability impact assessment of proposed WTO negotiations. Final report for the forest sector study. Indufor Oy in association with Impact Assessment Research Centre, Institute for Development Policy and Management, University of Manchester, UK.

Lindner M, Suominen T, Palosuo T, Garcia-Gonzales J, Verweij P, Zudin S, Paivinen R (in press) ToSIA – A Tool for Sustainability Impact Assessment of Forest- Wood-Chains. Ecological Modelling, doi:10.1016/j. ecolmodel.2009.08.006.

Palosuo T, Suominen T, Werhahn-Mees W, Garcia- Gonzales J, Lindner M (in press) Assigning results of the Tool for Sustainability Impact Assessment (ToSIA) to products of a forest-wood-chain. Ecological Modelling, doi:10.1016/j.ecolmodel.2010.03.020.

Rametsteiner, E. 2001. SFM indicators as tools in political and economic context: actual and potential roles. In: Raison, R.J., Brown, A.G., Flinn, D.W. (eds.). Criteria and indicators for sustainable forest management. IUFRO Research Series 7. CABI Publishing, Wallingford, UK. Pp. 107–130.

Rees, W., Wackernagel, M., 1996. Urban ecological footprints: Why cities cannot be sustainable – and why they are a key to sustainability. Environmental Impact Assessment Review 16, 223-248.

Verweij, P.J.F.M., Knapen, M.J.R., de Winter, W.P., Wien, J.J.F., te Roller, J.A., Sieber, S., Jansen, J.M.L., 2009. An IT perspective on integrated environmental modeling: the SIAT case. Ecological Modelling accepted.

WCED 1987. Our common Future. United Nations World Commission on Environment and Development (Chaired by Gro Brundtland) Oxford University Press, London.

Wiedmann, T., Minx, J., 2008. A Definition of 'Carbon Footprint'. In: Persova, C.C. (Ed.), Ecological Economics Research Trends. Nova Science Publishers, Hauppauge NY, USA, pp. 1-11.

WWF 2007. WWF Paper Toolbox. http://www. panda. org/paper/toolbox/ last visited 30.11.2009

www.cepi.org/Objects/1/files/CEPI-Report09Final(Web).pdf.3

www.eforwood.org

www.globalreporting.org/AboutGRI/

www.mcpfe.org/filestore/mcpfe/Publications/pdf/state_of_europes_forests_2007.pdf.2

www.sensor-ip.org

Selected official reports from EFORWOOD

To get access to the reports, please contact the project coordinator Kaj Rosén, kaj.rosen@skogforsk.se

D1.1.5 An updated and further elaborated policy database (including PD 1.1.9 A tested prototype of policy analysis interface for ToSIA)

D1.2.6 Report on data quality

D1.4.6 Documentation of ToSIA developments up to month 52 (Including D1.4.5 ToSIA version 1.0)

D1.4.7 Reference futures and Scenarios for the European FWC

D1.4.10 ToSIA Handbook documenting ToSIA functionality and use

D1.5.6 Monetary values of environmental and social externalities for the purpose of cost-benefit analysis in the EFORWOOD project

D1.5.7 Documentation of concept, implementation and use of the Multi-Criteria analysis Software component (ToSIA-MCA) in EFORWOOD

D2.2.3 Paper on impacts of forest management on environmental services

D2.3.3 Report on the impacts of forest management on social and cultural values in Europe "Public Preferences for Silvicultural Attributes of European Forests"

D2.4.3 Forest stands management and vulnerability to biotic and abiotic hazards

D2.5.7 Report describing the regional simulators and the European simulator

D3.3.3 Assessment of logistics concept to sustainability: Development of a common approach to transport issues

D3.4.7 Processes, Volume Flows and Values of Sustainability Indicators of the Chain of Technical Timber Production to Support the Tool for Sustainability Impact Assessment (Materials and Methods Using the Example of Poland; Results for Poland, Lithuania, Czech Republic and Hungary)

D4.1.9 Report describing the manufacturing processes in the EU cases (restricted)

D4.3.11 Final report on the interdependence between the agents with the FWC (restricted)

D5.2.4 Summary analysis report on consumers, wood based products and substitutes in the light of the forestry-wood chain sustainability concept including the identification of hot spots

D5.2.7 Report on training methods for the analysis of consumers' attitude to FWC products

Selected internal project reports from EFORWOOD

To get access to the reports, please contact the project coordinator Kaj Rosén, kaj.rosen@skogforsk.se

PD 0.0.16 Manual for data collection for Regional and European cases. UPDATE 3 September 2008.

PD1.0.6 Description of the EU-FWC

PD1.1.8 An updated and further elaborated policy database

PD1.3.5 Report by INCO partners on selected policy changes in TWC and Europe

PD2.1.5 Impact analysis on production of alternative forest management strategies based on simulations for European reference forest types

PD2.2.4 Report on quantification of environmental impact of forest operations ("response functions")

PD2.3.5 Research protocol to derive recreational scores for European forest management alternatives

PD2.4.7 Report on specific risk analysis in regional forests of Europe under various Forest Management Alternatives

PD3.0.3 Case study "Baden-Württemberg". Final report (restricted)

PD3.1.8 Mapping of properties in forest resources and models used - Results from EFORWOOD Case Studies in Västerbotten (North Sweden), Baden-Württemberg (Germany) and South Scotland

PD3.1.9 Illustration of sustainability effects from allocation. Results from EFORWOOD case studies on: Corrugated boxes from fibres of Västerbotten and Sawn products and bioenergy of South Scotland

PD3.3.6 Stratified partial model on transport (restricted)

PD4.1.10 Report describing the technology scenario

PD4.2.9 Technology scenario impacts

PD4.3.10 Final report on the industry's competitiveness and its impact on the industry dynamics

PD4.4.2 Industrial feedback for EFORWOOD

PD 5.3.2 Draft of Vision and Pro-active Sustainable Strategies (restricted)

PD5.3.3 Report on M5 Sustainability Process Tool - Qualitative SIA process tool (restricted)

PD5.3.4 Report on analysis of the draft Pro- active Sustainability Strategies and their implication upstream (restricted)

THE CONSORTIUM

Project Co-ordinator

The Forestry Research Institute of Sweden (Skogforsk)	Sweden	www.skogforsk.se

Project Partners

Albert Ludwigs University, Freiburg	Germany	www.fobawi.uni-freiburg.de
Alterra BV	Netherlands	www.alterra.wur.nl
Asociaci´on de Investigación y Desarrollo en la Industria del Mueble y Afines (AIDIMA)	Spain	www.aidima.es
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University of Natural Resources and Applied Sciences, Vienna (BOKU)	Austria	www.wabo.boku.ac.at
Warsaw Agricultural University	Poland	wl.sggw.waw.pl

CONTACTS

KAJ ROSÉN
kaj.rosen@skogforsk.se
Section: What is EFORWOOD; Managing a cross discipline project; Post project management
Affiliation: The Forestry Research Institute of Sweden
www.skogforsk.se

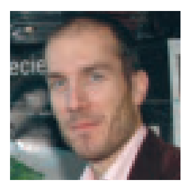
RISTO PÄIVINEN
European Forest Institute,
Finland.
risto.paivinen@efi.int
Section: Sustainable development
Affiliation: European Forest Institute, Finland
www.efi.int

MARCUS LINDNER
European Forest Institute,
Finland.
marcus.lindner@efi.int
Section: The ToSIA concept; The ToSIA toolbox; Case studies – introduction
Affiliation: European Forest Institute, Finland
www.efi.int

ERIC ARETS
Alterra,
The Netherlands
eric.arets@wur.nl
Section: Reference futures
Affiliation: Alterra,
The Netherlands
www.alterra.wur.nl

ERIK VALINGER
Swedish University of Agricultural Sciences, Sweden
erik.valinger@ssko.slu.se
Section: The Scandinavian technology case
Affiliation: Swedish University of Agricultural Sciences, Sweden
www.slu.se

FRANKA BRÜCHERT
Baden-Württemberg
Forest Research Institute,
Germany
franka.bruechert@forst.bwl.de
Section: The Baden Württemberg bio-energy case
Affiliation: Baden-Württemberg Forest Research Institute, Germany
www.fva-bw.de



LUDOVIC GUINARD
Institut Technologique
FCBA, France.
ludovic.guinard@fcba.fr
Section: The Iberian consumption driven case
Affiliation: Institut Technologique FCBA, France
www.fcba.fr

DIANA VÖTTER
European Forest Institute,
Finland.
diana.votter@efi.int
Section: The EU-case
Affiliation: European Forest Institute, Finland
www.efi.int

JEAN-MICHEL CARNUS
INRA - Centre
Bordeaux Aquitaine, France
carnus@pierroton.inra.fr
Section: Forest resource management
Affiliation: INRA - Centre Bordeaux Aquitaine, France
www.inra.fr

GERO BECKER
Albert Ludwigs University
Germany
institut@fobawi.uni-freiburg.de
Section: Forest to industry interactions
Affiliation: Albert Ludwigs University, Germany
www.uni-freiburg.de

HELENA WESSMAN
VTT, Technical Research Centre of Finland, Finland
helena.wessman@vtt.fi
Section: Processing and manufacturing
Affiliation: VTT, Technical Research Centre of Finland, Finland
www.vtt.fi

CARL OLSMATS
Innventia AB
Sweden
carl.olsmats@innventia.com
Section: Industry to consumer interactions
Affiliation: Innventia AB, Sweden
www.innventia.com

TRANSPORT

WITHIN THE FOREST WOOD CHAIN

Introduction

Transport occurs all along the forest-wood chain through different modes, equipments and logistics chains. However, the transport processes in different parts of the chain often have very few common features. For example, transport of roundwood from the forest to the mill and the transport of furniture to user in the last kilometres are very different.

Moreover, a process such as transport from the forest to the mill may involve different parameters as e.g. distances, modes, vehicles, loading rate, empty backhaulage etc. in different regions and/ or countries.

The objective of the transport study was to provide a comparison of the different transport processes between and within the forest-wood chain from a socio-economic and an environmental point of view.

In order to obtain comprehensive results, a limited number of indicators were chosen for the analysis. Furthermore, to compare transport on an international level, common and comparable processes were identified.

The first section gives an overview of the major sustainability impacts of transport of roundwood from the forest to the mill in the Scandinavian and the Baden-Württemberg case studies. Major "hot spots" were identified to explain differences between the two regions.

The second section shows three scenarios allowing an improvement of transport impacts from a sustainability point of view in the Baden-Württemberg case.

The last section illustrates that sustainability impacts of transport can be significant in the transport processes at the end of the forest-wood chain (delivery, end of life). In this study, all results are reported per tonne of product carried.

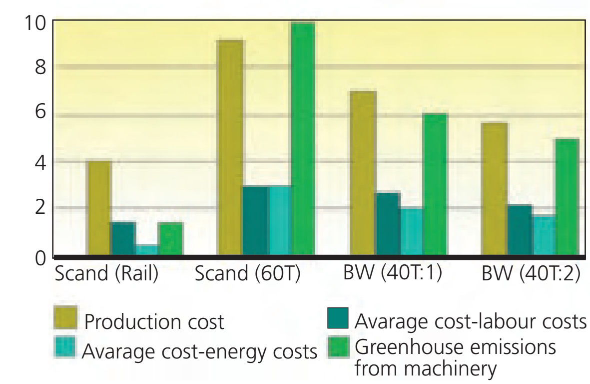
PHOTO: HANS WRETLING/MATTON IMAGES

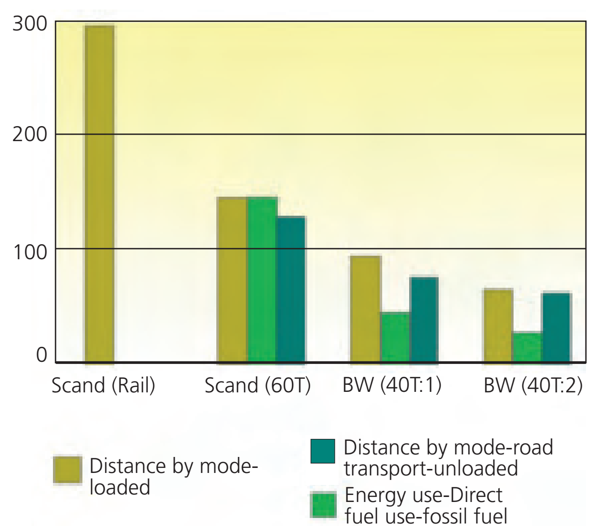
Scandinavian vs. Baden-Württemberg case: Transport of wood from the forest to the mill

Four processes were analysed:

- Two from the Scandinavian case study, one dealing only with rail and one dealing only with a 60 tonne vehicle with crane
- Two from the Baden-Württemberg case, both dealing with a 40 tonne vehicle.

Figure 1: Transport processes impact in the Scandinavian and the BW case studies





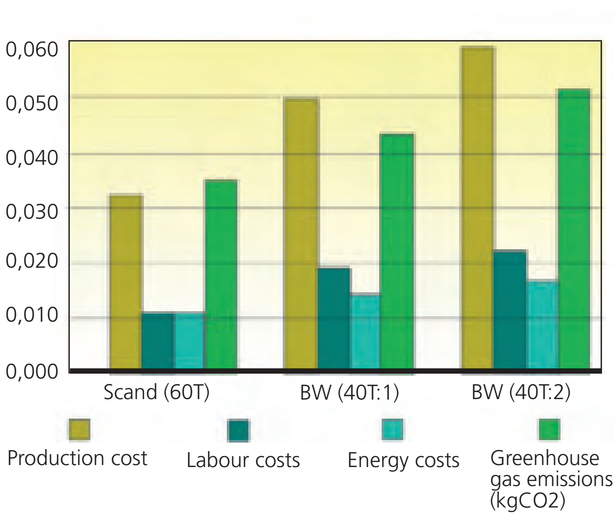
The first Scandinavian transport process, transport by train to pulpmill, is the cheapest regarding costs and the lowest in CO2-emissions for the longest distance (293 km). Even if this transport mode represents some key advantages in terms of sustainability, it is important to remind that empty-backhaulage is assumed to be nil as trains are assumed to be fully loaded and that loading and unloading costs and impacts are excluded from the study (as well as for other transport modes).

The other Scandinavian transport process analysed, transport by 60t truck with crane to pulpmill, involves a lower procurement distance (144km) but a substantial empty-back haulage rate (100%).

Similar processes in the Baden-Württemberg case involved shorter distances loaded and unloaded (respectively 93 and 45 km for transport of beech short logs and 65 and 27 km for Transport of beech long logs.

With such differences in distances, the Scandinavian process creates more costs and more greenhouse gas emissions than the Baden-Württemberg beech short log process, which in turn has a greater economic and environmental impact than the long process (figure 1). However, when costs and GHG emissions are reported per tonne kilometre (tkm), the order is reversed and the Scandinavian process can be considered as the cheapest and the least CO2-producing (figure 2).

Figure 2 : Transport processes impacts reported per tkm



The allowance in the use of a 60T truck generates a substantial economic and environmental gain because of the increase in the load capacities of the truck.

The difference between the two Baden-Württemberg cases is also related to the lower loading rate for the long logs (80% instead of 95%).

Consequently, it can be seen that, in relation to procurement distance, the main determinants of socio-economic and environmental transport impacts are:

- Transport mode
- Loading rate and loading capacities
- Empty backhaulage

FOTO: ANDREAS BARTH/SKOGENBILD

This focus has demonstrated that the logistics ofloading rate and empty back haulage do not appear to be optimal in the Baden-Württemberg case compared to the Scandinavian case study.

Improvement scenarios of transport processes

The next section provides an estimate of the impacts of transport in Baden-Württemberg according to the different scenarios, based on assumptions of optimal logistics and on the use of alternative transport modes/ vehicles.

The focus of this analysis is based on the Baden-Württemberg process "Transport of beech short logs" (40T. Procurement distance = 100 km. Loading rate = 95%. Empty- backhaulage rate = 48%).

Three cases were described:

• Scenario 1: Based on the same type of lorry (40T) and a similar procurement distance (= 100 km) but with an optimal logistics (Loading rate = 100% (ie 25T) and empty- backhaulage rate = 0%).

• Scenario 2: Based on a 60T lorry type (which is not allowed on public roads in Lorry's category

Germany) and on an optimal logistics (loading rate = 100% and empty-backhaulage rate = 0%. Procurement distance = 100 km).

•Scenario 3: Based on rail transport also with optimal logistics (Loading rate = 100% and empty-backhaulage rate = 0%. Procurement distance = 100 km).

The results (fig. 3) confirmed the conclusion that major improvements in impacts come from optimising the logistics. Indeed, a decrease in of empty-back haulage allows a reducion in GHG emissions and in production costs by respectively 25 and 16%. The difference between the 40T and the 60T trucks is substantial in terms of production cost but not in term of environmental impact (figure 2 and table 1). The rail transport mode remains the best in term of environmental impact (figure 3 and table 1) but should be considered with caution in terms of production costs because loading and unloading costs are neglected. Moreover, rail generally involves pre- and post transport by road which also has to be taken into account.

Figure 3: Optimal logistics scenarios in the BW case study

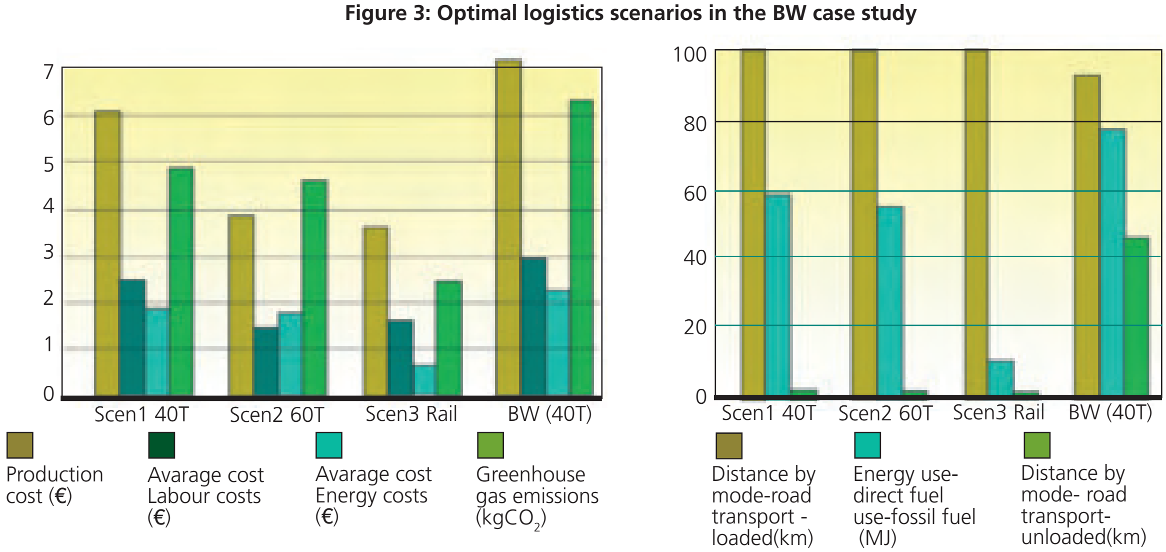


PHOTO: BJÖRN NORDIEN/MATTON IMAGES

Transport of roundwood vs delivery of furniture (last kilometres)

The last kilometres, in relative terms, have a major impact on transport within the forest wood chain. Accordingly, the process called "Transport of furniture from the retail to the consumer" involves a total distance almost three times lower than process called "Transport of beech short logs from the forest to the mill", but substantially higher production costs and higher GHG emissions (around respectively 300 and 900%).

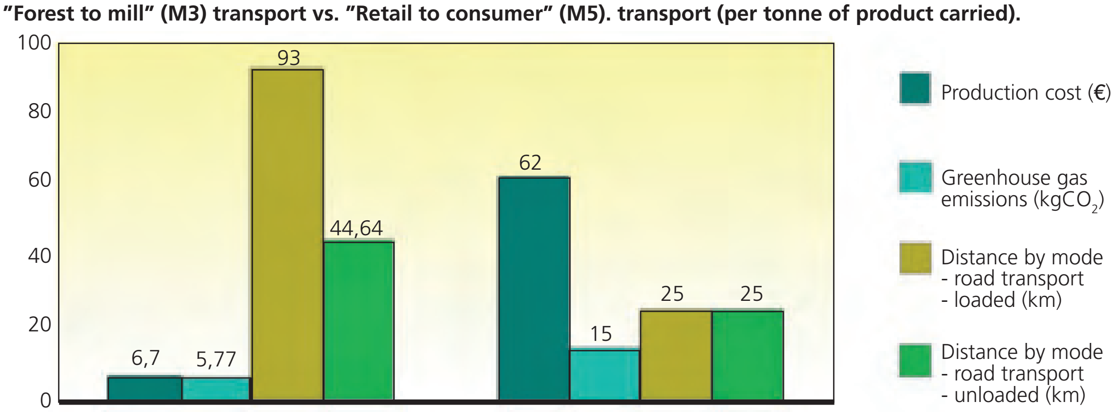
Conclusion

This short analysis on the socio-economic and environmental impacts of transport processes between and within the forest-wood chain showed two major results:

- Together with the mode of transport and the distance, logistics variables of loading and empty-back haulage rates are the main determinants explaining the difference between Scandinavian and Baden-Württemberg case studies. In the Baden-Württemberg case, these constitute potential leverage factors to improve the sustainability of transport prior to any change of mode.

- Transport processes at the end of the forest-wood chain (delivery, end of life) must be taken into account as their impact can be as large as those due to the transport of wood from the forest to the mill.

Figure 4: "Forest to mill" (M3) transport vs. "Retail to consumer" (M5). transport (per tonne of product carried).



Contact person
Jean Baptiste Chesneau
jbchesneau@gmail.com

DESIGN: PETER BERGMAN PHOTO: ERIK VIKLUND

SKOGFORSK

Uppsala Science Park, 751 83 Uppsala
Tel. 018-18 85 00. Fax. 018-18 86 00
E-post. info@skogforsk.se
www.skogforsk.se

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